RATIONAL EXPOSITION, &c.

A

RATIONAL EXPOSITION

OF

THE PHYSICAL SIGNS

OF THE

DISEASES

OF

THE LUNGS AND PLEURA;

ILLUSTRATING THEIR PATHOLOGY, AND FACILITATING THEIR DIAGNOSIS.

By CHARLES J. B. WILLIAMS, M.D.

Δεῖ ἄρα τὸν σοφὸν μὴ μόνον τὰ ἐκ τῶν ἀρχῶν εἰδέναι, ἀλλὰ καὶ περὶ τὰς ἀρχὰς ἀληθεύειν. ARISTOT. ETHIC. NICOM. ζ

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C. SMITH, ONE BELL YARD, STRAND.

TO

SIR HENRY HALFORD, Bart.

PRESIDENT OF THE ROYAL COLLEGE OF PHYSICIANS, PHYSICIAN TO THE KING, &c. &c.

My dear Sir,

To you, the learned and justly distinguished head of our profession, I dedicate this work. Were the illustrious inventor of Auscultation living, duty and inclination would have guided my pen to inscribe his name on this page. He is not; and when I turn to you for the sanction of this little production, I feel, that whatever slight merits it may possess, will meet with the approbation of an equally enlightened mind, and the urbane protection of a candid authority.

With every sentiment of respect and esteem,

I am, my dear Sir, your very faithful

and obliged Servant,

C. J. B. WILLIAMS.

London, May 21, 1828.

PREFACE.

A discovery, a new doctrine, or an innovation of any kind, produces a curious agitation in the public mind, which, in a remarkable manner, illustrates the paradoxical and heterogenous composition of human character. Tossed to and fro by the exertions of its opponents, and of its scarcely less opposing ultra-partisans, it resembles a pendulum; and vibrating irregularly between many disturbing forces, it is driven out of the real sphere of its importance, and from that true point of utility to which its intrinsic weight and worth would cause it to gravitate.

More particularly has this happened in medicine, which, having few standard or fixed points to steady it, has been ever too much at the mercy of contending opinions. The localization of diseases is a characteristic doctrine of the present day; and most assuredly such a system would be the most scientific, that could trace the multifarious forms of disease to a few simple primary lesions of tissue, or well defined alterations of function; and that plan of practice the most efficacious that could concentrate its efforts against the very root of evil, and stop at its very spring-source the current of disorder. But we are far from having attained such a perfection; and let caution, therefore, remind

us, that hastily to follow a light, which, however pure and real, is yet at distance too remote to shed its rays upon our paths, is scarcely less dangerous, than to chase an empty ignis fatuus; that to grasp at an object, however perfect and substantial, so far beyond our present reach, is not less futile than to catch at an illusory shadow.

The local study of diseases must not, therefore, remove our attention from their general phenomena; our examination of their physical nature must not exclude the consideration of many constitutional effects, that by reaction may often become converted into causes; and still less should physical signs of doubtful import make us neglect obvious disorder of the system.

But, thus limited, the local study of diseases is more advantageous than the knowledge of their general forms; an examination of their physical signs, when possible, more useful than the perplexing consideration of a host of uncertain and fallacious constitutional symptoms; and when physical signs are wanting, or beyond the sphere of our observation, those constitutional ones are our best guides, which most nearly depend on the physical and unchangeable character of the disease. For the local study of a disease acquaints us with its proximate and essential cause, and this knowledge suggests means for its removal; and by a study of its physical signs, and of those general ones most allied to them, we obtain the most certain method of discovering its existence, and of distinguishing its character.

Further than this, I shall not expatiate on the advantages or disadvantages of the new methods of diag-

nosis of diseases of the chest. They are now too well understood and appreciated to be in danger of yielding to the opposition of prejudice, or of falling into oblivion through neglect. Too many ears have been opened to the language of disease, to suffer its warnings to be lost without a listener; too many minds are convinced of the truth of its admonitions, to permit them to pass, as hitherto, unheeded. Those who are disposed to study the signs of auscultation and percussion, will soon find in that study the proofs of their merit and importance; those who will not examine them, are not likely to be more moved by any commendations that I could bestow, than by those that have already been written in their favour.

The "Traité de l'Auscultation Mediate," and the perfect translation of Dr. Forbes, are at length generally appreciated, even in this country, slow to award its meed of praise. The homage paid to the talents of the author, gives me a gratification that almost seems personal; and I doubt not that this feeling is shared by others of his pupils, in whom his urbane and amiable deportment created a sincere regard for the man, as his great mental abilities excited our respect. His great talents are known to the public through the medium of his writings; but those who attended his clinique can alone appreciate the wonderful acuteness of perception, and faculty for observation, that enabled him to carry his discovery to the degree of perfection in which he left it; and they, above all, witnessed, felt, and profited by the solicitous interest which he showed to make others partake of its inestimable advantages. They felt in his death the loss of a friend;

as science had to deplore the loss of his talents: he has wrought a good work for both; the feeling shall last while they last; science has recorded his name on her tablets for ever:—

"Illum aget pennâ metuente solvi
"Fama superstes."

Let me say a few words on the objects and plan of the present work.

I have ever found in practice, and it is perfectly conformable to reason, that the easiest and most agreeable way to study physical signs, and to attain the surest criterion of their value and importance, is by considering how they are caused, or what are the relations in which they stand to the physiological and pathological states that produce them. Attempts to discover the rationale of the general symptoms of disease have been as unsuccessful as our knowledge of the functions or properties, on which they depend, is scanty and imperfect; and inquiries of this kind have been proportionately unsatisfactory and unprofitable. But physical signs stand on the broad and intelligible basis of physical laws, and are as readily explained as other simple phenomena, illustrated by natural philosophy. It has been my endeavour to exhibit them, as far as possible, in this intelligible view; to show the mechanism by which the signs are produced, and the manner in which, according to fixed laws, they result as phenomena; to make a knowledge of the pathology predicate the signs, and a knowledge of the signs indicate the pathology; and by thus familiarizing the mind with their principles, to enable it to understand the multifarious forms which, by combination, these signs may assume, and to judge

of the corresponding physical changes that modify or produce them.

I have not refrained, when the subject seemed to require it, or where I had any new view to offer, from entering on some questions of general pathology. I am not clear that I have been judicious in so doing; for the slight views, that I have given of these questions, may be deemed too superficial and unsupported to be satisfactory; and had I developed them in the manner in which I am prepared to do, it would have completely changed the size and nature of the work. These opinions, as well as my acquaintance with the physical signs, are the result of some extent of study and observation, prosecuted chiefly in the wards of La Charité, where Laennec taught, and Andral prosecuted his labours. Most of the facts which I have described have appeared in the works of these illustrious men; and wherever my experience has not enabled me to give the same as the result of my own observation, I have referred to their competent authority. Where, in point of fact, or opinion, I have differed from them or from others, I would wish my dissent to be viewed rather as a question to be answered by others, than as in itself superseding former observations or opinions.

I have divided this work into two parts: the first contains an exposition of the general physical signs of a healthy and diseased state and action of the thoracic viscera, to which I have prefixed a chapter on the properties, &c. of sound; the second comprehends the pathological history, and physical signs, of the principal diseases of the lungs and pleura. I have inserted at the end of the volume some tabular views of

the physical signs, &c. illustrated by a plate, showing the situation of the regions of the chest. These are to be considered more as tables of reference to assist the memory, than as containing any exact or adequate expositions of their subjects. The diagram of the stethoscope, and the accompanying explanation of the best principles of its construction, I have thought worth adding, as workmen have hitherto had little but fancy to guide them.

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Hydrothorax.	Quite dull	Weak or extinct, according to the quantity of the effusion.	Ægophony, when the effusion is scanty.	Various.
Pneumothorax.				
a. Simple.	Unnaturally clear.	Weak or extinct, according to the quantity of air effused.	Generally none; rarely metallic tinkling.	Various.
b With fistulous communication with the bronchi, and liquid effusion.	Dull in the dependent parts; very clear above.	Ditto. Succussion of the chest produces sound of fluctuation. Respiration and cough, sometimes attended with amphoric resonance or metallic tinkling.	Metallic tinkling.	Phthisical.
Phthisis.				
a. Stage of grey induration, and crude tubercles.	Impaired, if the accumulation be extensive.	Weak, or somewhat bronchial, if the accumulation be extensive.	Diffused bronchophony, if the accumulation be extensive.	Sometimes catarrhal and scanty, sometimes pituitous, sometimes bloody.
b. Stage of evacuation of the softened tubercles.	Unequal.	Cavernous rhonchus, respiration, and cough.	Pectoriloquy, when the cavity is empty.	Muco-purulent; purulent; tubercular; curdy matter; sanguinolent; a grey or brownish grumous liquid.

A

RATIONAL EXPOSITION,

&c. &c.

PART I.—CHAP. I.

ON THE PHYSICAL SIGNS OF DISEASE.

BY *physical signs* I mean such as depend on the direct operation of known laws of natural philosophy on our organs of sensation. As they are produced by the physical state or condition of a part, they become indications of that state or condition, as certain, as the laws, of which they are exemplifications, are unerring and sure: and the physical state of a part of the body may be ascertained with more or less certainty, as its physical signs, or relations to these natural laws, are more or less appreciable by our senses.

The organs of *vision*, impressed by the forms and properties in relation to light, and perfected

by the immediate correction of touch, are, both by nature and habit, calculated to give us a more perfect knowledge of external objects, than can be derived from the other senses. But the number of diseases that come under the cognizance of vision is very limited, as by far the greater part of the body is excluded from its sphere. Derangements of the surface, and of the openings of some of the passages to the interior, can alone be subjected to the direct examination of the eye. Mediately, physical changes of internal organs can be perceived by sight only, when their size, form, or position is so far altered as to cause displacement of some external part; and the knowledge that such a sign gives us, although scanty, is often valuable.

The sense of *touch*, or *tact*, will, in the same cases, furnish us with further knowledge as to the form, substance, and constitution of a diseased part; and, when perfected by experience, may frequently discover organic changes that are altogether imperceptible to sight.

The sense of *smell* is more rarely qualified to distinguish disease; as its impressions can only be conveyed through the medium of air, probably in motion; yet we shall find that cases are not wanting in which this sense may assist us in diagnosis.

Sound, as it may be both generated and pro-

pagated in every form of matter, solid, liquid, and aeriform, may be therefore considered a mean of examination of parts removed from sight and tact, more promising as its sphere is less limited. It is requisite, however, that the object of examination be capable of producing or transmitting *audible* sound ; and that changes in the part produce corresponding changes in sound thus produced or transmitted, that may be appreciated by the ear. The relations of the organ of hearing to the qualities of external objects, are, in ordinary life, much less exercised than those of tact and vision. Yet continual experience proves to us that the substance or consistence of simple objects is, in some measure, declared by the sound which they emit when struck. The sound of liquids in contact with air is familiarly distinguished from that of solids in the same medium, and a little more attention discovers the varied sounds which air in motion produces in contact with solids of different forms.

Such scanty knowledge of the relations of sound suffices for the common purposes of life : to study them more closely, with a view to discover the nature of objects, were a work of supererogation whilst sight and tact are capable of giving us much more perfect and certain information. But an individual deprived of sight

substitutes a perfection of tact and of hearing and distinguishing sounds, which, in a great degree, compensates for his want of vision. So likewise may we, with equal advantage, so perfect our sense of hearing, as to make its indications available to instruct us of objects beyond the sphere of tact and vision. Now such perfection must in great measure depend on the practice of each individual, as a knowledge of simple sensations cannot be transferred by description; but the study may be much assisted and simplified by a general knowledge of the chief laws according to which sound is produced and propagated. Unfortunately acoustics is a branch of natural philosophy that has been neglected to an unaccountable degree; and when I refer to the works of authors on the subject, it is but to a scanty source, and supplying little information applicable to our subject. It would be beyond its purpose to introduce in this work an attempt to supply this defect, nor indeed am I prepared to do so in the systematic form which the subject requires; but there are a few points relating to sound, which must be known before we can understand those phenomena which it is a great object of this work to explain.

Sound is an impression communicated to our sense of hearing by certain vibrations of mat-

ter. All matter is susceptible of sonorous vibrations; but the degrees of this susceptibility are as varied as matter is diversified in form and nature. As a general rule it may be stated *that it is in proportion to the strength of the molecular elasticity* in the matter.

This term *molecular elasticity* may, perhaps, require a little explanation. I mean by it that force by which the molecules of a body are held at a certain distance from each other, and resist any effort to displace them from it. Thus, glass and steel may be said to possess molecular elasticity in a powerful degree, because any external impulse is instantaneously communicated from particle to particle throughout their whole mass; and it is not lost or broken by the yielding or displacement of the molecules at the point struck. Air, and other fluids, on the other hand, cannot readily be thrown into vibrations, unless the impulse be applied to some extent of surface, by which it becomes communicated to many particles at once.

This rule is, however, much too abstract to apply directly to the common instances of the generation of sound; for it is not always the hardest bodies that produce the loudest sounds in our ears. But we must separate the physical from the physiological phenomenon, in order to analyze each into its respective elements. I

conceive that the motion of matter producing sound, should be considered as molecular, although the result is the vibration of the mass. I would explain the production of sound as follows :—An impulse is impinged on certain molecules; this, momentarily overcoming the resistance of the quiescent forces, causes these molecules to start from their place; that force of repulsion, which existing between the different molecules resists the attempt to approximate them, transfers the impulse from molecule to molecule, and thus extends it throughout the mass. The impulse that forced these molecules from their position being exhausted, they spring back, by virtue of their attractive and repulsive forces, to beyond their original situation, and are again driven back; until, by a series of these alternating vibratory motions, the disturbing force is lost.

The assimilatory power, then, that these vibrations possess, depends on the molecular elasticity of the body, that is to say, on the repulsive and attractive forces that subsist between the molecules of which it is composed; and it is evident that this assimilatory or propagating power will be more effective in proportion as the molecular elasticity is strong and perfect. It is likewise apparent that uniformity, or equality of molecular elasticity

favours the propagation of sonorous vibrations. For if the elasticity of some molecules be less than that of others, the reaction being less, will produce vibrations not consentaneous with those of the others, and may impair, or even destroy them. Let us illustrate this by the vibrations of pendula. Suppose a number of pendula suspended in a line, and in the act of vibration. If these pendula are of the same length, the vibrations will be equal and consentaneous, and will neither interfere with, nor interrupt each other. Such are the vibrations in bodies whose molecular elasticity is uniform. But suppose the pendula of different lengths, and the vibrations, therefore, unequal, the motions would then interfere with and neutralize each other, and this the more effectually, the more varied and irregular they are.

There are, however, some vibrations that, although they are not synchronous, nevertheless promote each other, and these constitute what are called harmonic sounds. To show how this is effected, let us again refer to the pendulum. We have already remarked that pendula of the same length vibrate synchronously, and may, therefore, promote and strengthen each other. This is the harmony of unison. Suppose one pendulum half the length of the other; it makes double the num-

ber of vibrations in the same space of time, and being regularly in the same ratio of striking two for every one of the other, the vibrations do not counteract each other. This concord or harmony of vibrations of sound produces the harmonic note of the octave. The same illustration will enable us to conceive the harmonics of the fifth, the fourth, and the third; the ratio of their vibrations being as 3 to 2, 4 to 3, and 5 to 4 of the key-note; and in like manner of other harmonics. Now it is necessary to be aware of these relations, in order to understand the production of such sounds as we are accustomed to hear; for, owing to the variable molecular elasticity of the bodies in which they are produced, these sounds are always compound, and consist of a variety of vibrations, which may increase or neutralize each other according as the arithmetical relations of their motions harmonize or disagree.

The propagation or conduction of sound from body to body, is subject to the same rule; and, in fact, it consists in the transmission of the same impulse, producing sonorous vibrations, from one body to another. A sound will, therefore, *cæteris paribus*, be best conducted by those bodies which approach in degree and strength of molecular elasticity the body in which that sound is generated. Thus a sound

produced in air will be best propagated by air; one produced in a solid will be most completely conducted by a solid of the same density and hardness, &c. On the other hand, bodies, very different in density, receive and transmit sonorous vibrations very imperfectly. Thus air transmits, in a very impaired degree, the sounds produced in dense bodies, such as metals; and the sonorous vibrations of air are scarcely received by dense bodies.

The sounds produced by the collision of solids, and transmitted to us through air, are, nevertheless, among the loudest that we hear; but this is by reason of the law before stated, that those bodies are most susceptible of sonorous vibrations, in which the molecular elasticity is greatest, as well as most uniform; and such sounds are incomparably louder when heard through solids, instead of through air. The transfer of sonorous vibration may, however, be greatly favoured in another way, by bringing a large surface of the solid vibrating body in contact with the air, and otherwise modifying its form, as in the case of bells, &c. This is a separate branch of acoustics, and is not sufficiently connected with our subject to require notice here.

There are many substances, that prove bad conductors of sound, from their being of un-

equal density; and those are worst in which this inequality is greatest. Linen and woollen stuffs are examples. The threads of which they are composed leave interstices, which contain air of very different density from the solid fibres. In paper and pasteboard, the same fibres pressed closer together, and forming a more solid mass, become a far better conductor. The same is the case with all spongy bodies.

It now becomes apparent why the loudness of sounds does not always appear to us proportioned to the hardness and density of the bodies in which they are produced. Air is commonly the medium through which sounds are conducted to our ears; and this is a body of such tenuity that it much impairs those produced in solids, although, physically, they are the loudest. We are thus relieved from the danger of injury to our organs of hearing, from sounds that might be too powerful for them to bear; and this happy provision supersedes the necessity of providing them with a defensory apparatus for their occasional occlusion, which we find to be in various degrees necessary for the other organs of sense. In most of the loud sounds, therefore, which we are accustomed to hear, air is the sonific body, as well as the conducting medium. The sound of the voice, of most musical instru-

ments, of explosions, &c., originates in air. In some of these, such as explosions, flutes, and other instruments of the whistle kind, air produces the sonific impulse as well as the sound, and such sounds conveyed by air may be of a most powerful kind; but can be only imperfectly transmitted by solid conductors. In the sounds of reed instruments (among which I do not hesitate to class the human voice), air is equally the sonorous body; but it is thrown into sonorous vibrations by the mechanical motions of a solid, producing little or no sound themselves. The hum of insects is a remarkable example of the same kind. The rapid motions of their wings produce in air a corresponding series of vibrations, which, when it attains a certain degree of rapidity, produces sound; and this sound is more acute as the rapidity is greater beyond this degree. The vibration of cords, I believe to be in the same predicament; for the sounds which they produce have no relation to the sonorous qualities of the substances of which they are formed; but entirely to the elastic tension in which they are longitudinally kept, and by means of which an impulse, deranging their equilibrium, occasions a series of transverse vibrations, which, communicated to air, if sufficiently rapid, produces sound.

Sounds produced by the percussion of solids

are little, if at all, *dependent* on the surrounding conducting medium; but they become *modified* in intensity, and even in kind, by this medium, according as it differs in density from the solid in which they were produced. When this difference is great, a third body, of intermediate density, will very much facilitate the transmission of the sound to our ears. Thus, the percussion of hard metallic bodies sounds much louder when they are in contact with wood, because this substance of intermediate density transfers the vibrations with greater facility from the metal to the air. I may give the common pitch bar as an example of this. It produces little sound after it is struck, as long as it is held between the fingers, but no sooner is it placed on its end on the table or pianoforte, than its sound becomes distinct and clear.

I am thus led to consider the power of different media to conduct sound, not as an absolute and unchangeable quality, but as dependent on the relations in point of elasticity of their molecules to the substance from which they receive the sonorous vibrations.

The reflection of sound has relation to the same qualities of substances, but in a converse way. When, for example, a sound is produced in a very rare medium, such as air, the force with which the vibrations are propagated from par-

ticle to particle, is weak, because the molecular elasticity is weak, and being, therefore, incapable of communicating its vibrations to any hard, dense, and incompressible solid with which it may be in contact, the resisted impulse is reflected back to the air itself; and this more perfectly, the greater the difference in molecular elasticity between the air and the solid body. The laws of the reflection of sound are nearly the same as those of the reflection of light; the angle of reflection being equal to the angle of incidence; and this analogy greatly facilitates our study. I must observe, however, that the analogy is not perfect in observation; for the greater materiality of the media of the vibrations of sound exposes them to a greater number of disturbing influences, which impair or disguise the operation of the law. Thus, from motion, difference of density, &c., sound seems often to be propagated through air in curves, instead of in straight lines; and from there being always reflection where there is diversity of matter, sound is more easily diffused than light.

CHAP. II.

ON THE PHYSICAL SIGNS OF THE STATE AND ACTION OF THE THORACIC VISCERA.

It has been remarked that no parts of the body require the assistance of an additional sense to discover their state so much as those contained in the thorax. Excluding equally with other parts the scrutiny of vision, and by reason of their bony case more than they beyond the reach of tact, the thoracic viscera would have remained in more than the common obscurity and uncertainty of signs produced by equivocal and inexplicable sympathies, and still more fallacious sensations, had not the immortal discoverers of auscultation and percussion pointed out the peculiar adaptation of the chest to afford to our organs of hearing more certain indications of the state of its contents. And so effectually is the lacuna filled by the exercise of a sense that may be said to have been hitherto useless in the physical investigation of disease, that the diseases of the chest may now be ranked among those most within our powers of examination. For, unlike some others (the brain for example), the lungs and heart have no such complexity of

structure, or obscurity of function, as to render signs of their physical state of little avail to explain their disorder, or to suggest means for their cure. We see in these organs a mechanism of structure admirably adapted for its known office; we know that the perfect state of this mechanism is necessary to preserve the integrity of the function; and we can perceive, when that becomes deranged, how this must necessarily suffer. The signs by which such derangements are commonly distinguished, arise not so much from the diseased part itself, as from the disorder which it may produce on the functions and sensations. Now, as it is impossible to find a standard by which to judge of the health of a function in individual cases, and as sensations are frequently so elusive as to baffle our attempts to trace them to their source, the common method of diagnosis not unfrequently fails to detect even the existence of a disease; and even when the signs of disordered function and local pain are so distinct and prominent as clearly to prove that disease is present, they generally leave us in more or less doubt as to its nature. They have still their importance, and until lately have been our sole guide in the employment of a practice by no means unsuccessful. Let us not then exclude these from our view, whilst we study other signs which promise us still greater

certainty. Ages have passed away without leaving us materially improved in our diagnosis after the old method: another is now offered to us, on the more certain and intelligible basis of physics, which discovers signs which are identical with the physical nature of the disease.

There are two classes of sounds from which a knowledge may be obtained of the state of the thoracic viscera. One description or class is, for the most part, naturally produced by the motions of the organs within the chest, and is heard by the direct or mediate application of the ear to its parietes. These are the signs of auscultation. The other class of sounds is produced artificially by striking the chest; these constitute the signs of percussion. These last I shall first notice, not that they are prior in importance, but because they are more simple, and are generally consulted in examination before the fuller and more satisfactory ones of auscultation.

Section I.—*On Percussion.*

The chest of a person in health yields, when struck lightly by the ends of the fingers, a hollow and somewhat drum-like sound. The resonance thus produced arises from the air contained within, in the spongy tissue of the lungs, which receives the impulse through the

thoracic parietes. But in order that the impulse be propagated, these parietes must possess a certain degree of elastic tension; for if they are flaccid, and yield to the stroke of percussion, no sound will be emitted but that slight and obtuse one produced by the fall of the fingers upon the surface. The natural compact of the chest, with its frame of bone, attached by elastic ligaments and cartilages, and invested by a covering more or less tense, of muscles and integuments, is generally well adapted to transmit to its interior the impulse of external percussion: but if the elasticity of the cartilages be in any way lost, or if the integuments become thickened by œdema, fat, or other cause, the resonance on percussion will be proportionately diminished; and these causes of modification of the pectoral sound must be carefully separated from those depending on the state of the internal organs.

In the natural and healthy state, as the clearness and fulness of the pectoral resonance on percussion depends on the air-filled structure of the lung, and the tenuity and tension of the containing parietes, it is evident that those parts of the chest will sound best that most completely present these conditions. Our anatomical knowledge will therefore point out the different degrees of sound that the different

parts of a healthy chest should emit. Thus, the anterior and axillary parts of the chest should sound well; but in most of the posterior region the thickness of the soft parietes must render the sound more dull, and the same effect may be produced in the inferior parts by the contiguity of the abdominal viscera. For a more specific detail of the natural sound of each part of the chest, I refer to the table of the regions into which Laennec has divided the chest.

The manner in which diseases modify the pectoral resonance, is by changing the density of the contained organs. If, for example, a liquid or solid effusion take place in any part of the lungs or pleura, the corresponding portion of the chest will yield a dull, dead sound, and without that hollow resonance which is naturally produced by air underneath. On the other hand, when the aeriform contents of the cavity are increased beyond their usual proportion, as in pneumothorax and emphysema, the natural resonance may be increased to a degree that sounds quite tympanitic.

The practice of percussion requires some manual dexterity; and as on this, in great measure, depends the correctness of its indications, I shall bestow a few observations on the best method of percussion. It is of very little consequence whether the patient be sitting or

standing, or sitting up in bed, provided we hold in mind that all the sounds, bad and good, are rendered somewhat duller in the latter case, by the vicinity of the pillows and bed-clothes, which destroy the resonant echo accompanying sounds in more empty rooms. The same amount of difference may be perceived in different rooms, when percussion is practised in the standing or sitting posture. In some cases of debility, and of painful disease, the patient can bear no other than the recumbent posture; and in the parts where percussion can be practised, the sounds are somewhat more dull in these cases, from the deadening effect which the bed has on them. Thus warned, a little practice will enable the student to avoid error from these causes.

The part on which percussion is practised should be covered with a linen or cotton garment *, to render the stroke of percussion more equable, and to prevent its producing pain; and for this purpose a shirt or bed-gown kept on, answers very well, if care be taken to keep it smooth and close on the surface, by the fingers of the left hand.

* I find that Dr. Forbes thinks this precaution unnecessary (Translation of Laennec). I believe that the tact furnished by experience may, as I have afterwards observed, supersede this and other precautions; but it is necessary for a beginner, particularly where the soft parietes of the chest are thick.

Percussion is generally performed with the three first fingers of the right hand, held in such manner together, that, with their last joints at right angles with the surface to be struck, their tops shall fall simultaneously on it. The stroke must be made lightly, and with a jerk, by drawing the hand back the instant it has fallen, as if it struck something elastic which repelled it; and by a stroke thus made, as momentarily as possible, the fullest and clearest sound is elicited. It is of importance to attend to the manner in which the phalanx of fingers falls on the chest; more or less in the transverse direction of the ribs is generally the best position; but, above all, it is quite indispensible that, in making comparative trials of the *two sides* of the chest the *same* method be adhered to; for gross errors may be the consequence of striking on one side across, and on the other along the ribs, as the sounds often differ considerably when produced in these different manners. I might go into minute details of many modifications which I have found advantageous in the employment of percussion in individual cases; but his own experience will furnish such knowledge to each observer far better than the most elaborate instructions that I could give. I shall only remark in exemplification, that the examination of circumscribed spots can be best

effected by percussion with a single finger (as on the clavicle, a rib, &c.), whilst a general and tolerably accurate survey of the chest may, with economy of time, be often obtained by percussion with the flat hand, avoiding, in this case, the jerk necessary in the other method. This, I must, however, add, should be trusted to only by the experienced ear.

Laennec remarks that, besides the difference of sound, percussion, on a healthy hollow chest, gives a peculiar vibratory sensation to the fingers of the percussor, quite different from the dead feel of percussion over a part of the chest destitute of elastic air. To those who have sufficient nicety of tact to perceive this distinction, it may give additional evidence not without its value.

The force required in percussion is not by any means to an amount sufficient to produce pain in the generality of instances; but there are some cases in which the parietes of the chest are particularly tender, and here percussion may, with advantage, be made mediately, in the manner recommended by M. Piorry. This is done by interposing a thin lamina of wood, horn, or ivory on the part to be struck, so that while the impulse of percussion is perfectly transmitted to the interior of the chest, it is so diffused on the surface covered by the

lamina as not to produce pain. The same contrivance I have found equally useful where, on account of fat, œdema, &c., unguarded percussion could not be practised with sufficient force to produce the resonance of the interior, without annoying the patient. To avoid multiplying apparatus, I have always used the horn ear-piece of the stethoscope, which for this purpose I have made very thin; and to prevent the clacking noise produced by the fall of the fingers on its hard surface, I have it lined with soft leather; and thus prepared, I have found this little contrivance perform this part of its double office better than any *plexímeter* that I have seen. Held by means of its raised rim, with its concave or outer side in close apposition to the chest, it presents its inner side covered with leather for percussion, which may be practised with the tops of the fingers as usual, or with any other solid object of convenient form.

Such is the mode of obtaining signs of the physical state of the contents of the chest by percussion. The indications thus obtained, although they only relate to the density of the parts, are of great value, and alone may sometimes detect disease that all other signs leave in obscurity. But their importance and value are vastly enhanced, when they are combined with, and corrected by, the more numerous and

precise signs discovered by auscultation; these I proceed to consider.

Section II.—*On Auscultation.*

The signs of auscultation are those sounds produced in the chest, which may be heard by the direct or mediate application of the ear to its parietes. Now, I shall endeavour (and the same will be my object throughout this little work) to trace these signs to their physical causes, and by thus exploring the relations of diseases to certain and unchanging laws of natural philosophy, to place their characters beyond the doubtfulness and obscurity of sympathetic and sensatory signs.

I have before remarked that the sounds heard by auscultation are, for the most part produced by the natural movements of the organs contained within the chest. These movements are, those of respiration, to which may be added the voice; and those of the heart. Let us consider the manner in which these several motions give rise to sound, and we shall then be enabled to perceive *à priori* the modifications in it that disease may produce.

The ingress and egress of air in the lungs cause a sound of a peculiar nature, differing somewhat according to the part in which it is heard. This difference arises solely from a

diversity in the size of the tubes, through which the air passes, and by a knowledge of this we may, therefore, easily judge what these differences ought to be. Between the scapulæ (for example) in the upper part of the axillæ and in the upper sternal region, the sound is hollower, more tubular and blowing, because in these regions many bronchial ramifications of considerable size come so near the surface of the lung, that the sound produced by the passage of air through them is heard more distinctly than the duller and more diffused murmur which has its seat in the smaller bronchi and air cells. It is this latter sound, on the other hand, that prevails in other parts of the chest; for although there is bronchial respiration in these parts likewise, it is not sufficiently near to the surface to be transmitted through the spongy and ill-conducting tissue of the lung.

It is of great importance to be able to distinguish between the sounds which the passage of the air produces in the trachea and larger bronchi and in the extreme bronchi and vesicles; which different kinds of respiratory sound, we shall, with Laennec and Andral, distinguish by the epithets tracheal, bronchial, and vesicular. Rather than attempt to convey an idea of these sounds by description, I will refer for

the illustration of tracheal respiration, to the anterior and lateral parts of the neck, the superior sternal region, the sternal portion of the subclavian regions, and the cervical portion of the acromian regions; of bronchial respiration, to the middle portion of the sternum and those parts of the mammary regions contiguous to it, and in thin subjects to the principal part of the interscapular and axillary regions; and of vesicular respiration to the remaining parts of the chest. Such are generally the situations of the different kinds of respiratory sound; but, as might be expected, the distinction may be much more easily made in some subjects than in others, and the characters can in a corresponding degree be severally recognized.

There is a considerable difference in the intensity of the sound of respiration in different individuals; and this depends partly on the thickness of the parietes of the chest, but principally on the degree of activity of the respiratory function. Increased thickness of the parietes of the chest by fat or œdema does not very materially impede the transmission of sound of respiration to the ear, for being nearly of equal density, they form still a pretty good conductor of sound. From the same circumstance, the respiratory murmur is most distinctly

heard in those parts of the chest where the parietes are thinnest.

The degree of activity in the function in a much more remarkable manner determines the intensity of the respiratory sound; and the variety which different individuals in this respect present, even in health, is a matter of much physiological interest. We know that in like manner other secernent functions, as those of the kidneys and skin, vary in different individuals, under the same circumstances, in the degrees of their activity, and we may range the present instance amongst them. Were we to enquire still further into the causes of these differences, we should probably be led to conclude that they all have relation to a certain standard of organic activity or irritability, in some manner dependent on the physical constitution of the body. From this obscure point of constitutional difference (which we can only generalize, and not explain) let us turn to some changes in the respiratory sound that may take place in the *same individual* within the bounds of health.

I have remarked that it is more distinct after meals than at other times, which fact accords well with an ascertained point in animal chemistry; and proving that a greater activity of function is at that time required, it likewise

furnishes an additional reason why persons affected with habitual dyspnœa, should then most feel the incapacity of their organs. Moderate exercise likewise increases the respiratory sound; but violent exertion has a tendency to produce an opposite effect; for, when the muscles of respiration are exerted beyond a certain degree of activity, the dilatation and contraction of the lung cannot always keep pace with them, and the bronchial muscles are thrown into a state of irregular spasmodic contraction (probably increased by the congestion of blood in the lungs,) which is gradually relieved by the returning moderation and regularity of the respiratory effort. This is much more remarkable in persons unaccustomed to exertion and advanced in life, than in the young and active; and I think we should not use too mechanical a term, if we say that this proceeds from the greater *rigidity* of the lungs in the former. This leads me to the remarkable peculiarity that the respiration of very young individuals presents to the auscultator.

From birth till about the period of puberty, the sound of respiration is much louder, and more shrill than in after life; the passage of the air, producing it, seems much quicker, and the function appears to be in an extreme of activity. That the sound of *puerile respiration* (as

Laennec terms this modification,) proceeds from no peculiarity in the structure of the lungs of children, is proved by the fact that it is occasionally produced in adults, when one part of the lung is called into increased activity, to supply the defect of another incapacitated by disease. So also in adults, after a temporary suspension of respiration, as in reading or continued utterance, the respirations are often attended with a puerile sound; for being more rare, they are made with greater perfection and energy than usual. About the age of puberty the sound of respiration becomes deeper and less noisy, and in a few years, sooner or later, gradually assumes the character of adult respiration.

This change I am disposed to attribute principally to a greater comparative development of the lungs at that age, rather than to a diminished activity of their function. It is at this period that the muscular system developes itself more fully, and to support the occasional exertion of its augmented power, the organs of the chest acquire an increased capacity, and a more extended sphere of activity. The pulse and respiration becoming slower in their standard of rest, offer a greater range in their dynamometric scale, and although, from increased capacity, their common activity is diminished,

they have greater capabilities in reserve to support the occasional exertions of increased muscular strength. We find, accordingly, that in young persons above the age of puberty, increased exertion renders the respiration puerile, (that is, more active), and is therefore easy; and as long as this supplementary power of the lungs is moderately exercised, by occasional increased muscular exertion, it will be preserved; but, on the other hand, it will be lost by disuse; the organs will become rigid in their limited sphere of action; occasional exertion will be attended with the anhelation and spasmodic action of the bronchi before alluded to; and the attacks of disease, on a function that can scarcely bear abridgement, must be felt with a greater degree of severity:—an addition to the volume of arguments in favour of regular and active exercise.

As the sound of vesicular respiration is produced by the perfect penetration of the air into the lungs, its simple and equal presence may be regarded as an index of the healthy performance of the function; and as no physical change can interrupt or modify this function without interrupting and modifying the sound, the study of these latter changes will lead us to a knowledge of the physical changes that produce them.

The total absence of respiratory sound in a

part, indicates that the air no longer penetrates there, either because something excludes its entry into the pulmonary tissue, or because this tissue is pushed away from the parietes of the chest by an effusion into the pleura. An appeal to the signs of percussion is here necessary to ascertain in what manner the lung is invaded or surrounded. If the sound on percussion remains natural, the obstruction is probably situated in some of the bronchial branches leading to the part, whilst the vesicular texture contains its due quantity of air; if it is dull, there is liquid or solid effusion, either in the vesicular structure of the lung, or in the intervening pleural space; but if it be clearer than usual, there is either emphysema of the lung, or an aeriform effusion in the pleura. The inquiry thus simplified can now be specifically directed to the distinctive characters of individual diseases, presenting either of these physical conditions.

Sometimes the sound of natural vesicular respiration is absent, and a kind of hissing bronchial respiration is heard instead. Now, as the sound of the passage of the air in the bronchial tubes cannot be usually heard through the spongy and ill-conducting vesicular texture, it must be supposed that either the bronchial respiration is louder than usual in these cases,

or, that the tissue of the lung is, by some change, rendered a better conductor of sound. But increased loudness of the bronchial respiration would not explain the absence of the sound of the vesicular. Abandoning, therefore, this alternative, we shall find in the other an explanation of both modifications; for a liquid or solid effusion, at the same time that it obstructs the entry of air into the cells, likewise so condenses the tissue as to enable it to transmit, from its interior, sounds that are not usually heard.

A sound, resembling that of tracheal respiration, is sometimes induced by disease, in parts where vesicular respiration alone is naturally heard; and this phenomenon is caused by the passage of the air in a cavern or ulcerated cavity communicating with the bronchi. The sound thus produced, which is called cavernous respiration, is so remarkable, and so like the blowing of air into any little hollow object, that the mind would at once, and, as it were instinctively, refer it to its true cause.

There is a remarkable class of sounds produced by partial obstructions to the passage of the air through the bronchial ramifications. These sounds, which are called *rhonchi**, may

* I prefer the Latin term *rhonchus* (Gr. ῥόγχος) to the French *râle*, and the English *rattle*; for it both expresses the subject better, and is more accordant with the usual style of medical language. If an English term

be divided into the *dry* and *humid.* The dry rhonchi are those sounds produced by the passage of the air through bronchi, which have some part of their calibre contracted by a substance more or less solid. This contraction may be produced by a partial tumefaction of the membranes of a bronchus, by the pressure of an adjacent tumour, or by some body, such as a portion of thick mucus, within its tube; and the form and size of the isthmus, or contracted point, will determine the nature of the sound. Thus, we often hear an acute whistling sound, which is therefore called the *sibilant* rhonchus; and as we know that such a sound may be produced by air passing through a small circular aperture*,

must be used, the word *wheeze*, adopted by the editor of the Medico-Chirurgical Review, is the least exceptionable. To that editor the profession is, and, in course of time, will hold itself indebted for the candid and philosophical spirit, in which he, at an early period, recognised and proclaimed the advantages of auscultation.

* It must be observed, that to produce a whistling sound by the passage of air through a round aperture, there must be a certain proportion between the velocity of the air and the size of the aperture. I may remark here, that I think Dr. Forbes mistaken in translating *sibilant* by the word *hissing*. The rhonchus, called here sibilant, and frequently pointed out to me by Laennec as such, is a perfect *whistle*; whilst the sound of bronchial respiration has more of the *hissing* character. Hissing and whistling, however, approach each other in their physical cause; the principal difference consisting in the more forcible passage of air through a more flattened orifice in the former. The two terms are identified in Latin and in French by the words *sibilare* and *siffler*. The English have now so set apart the former, as a powerful means of expression, from the latter, which may be made by no means contemptible for music, that they could not now well spare the distinction.

it may be supposed that a contraction of this kind causes it in this case.

The *sonorous rhonchus,* which sometimes resembles snoring, sometimes the buzzing of an insect, sometimes the bass note of a violoncello or bassoon, is rather produced by a flattened contraction in a bronchus of considerable size. This contraction, which leaves little or no gaping aperture, throws the air passing through it into sonorous vibrations, after the manner of the reed of the hautboy, or the lips in blowing a horn or trumpet; or, perhaps, the production of this sound is still more completely represented in the manner in which a celebrated ventriloquist imitates, with his lips, the buzzing of a fly.

The *dry mucous rhonchus* may be said to be a coarse modification of the preceding. It resembles the sound of a click wheel; and is produced by a portion of very viscid mucus attached to the interior of a bronchial tube, which yielding with a jerking resistance to the air forcing its passage, thereby causes a ticking sound. Such is, in fact, the analysis of the sonorous rhonchus; for it only requires that the air should pass more speedily, and the tickings be multiplied until they seem continuous, to convert the dry mucous into the sonorous rhonchus.

The *humid rhonchi* arise from the presence of fluids in the bronchial tubes. The commonest, and the most obvious in its nature, is the *mucous* or *bubbling rhonchus*, a sound which the mind at once refers to the passage of air in bubbles through a liquid. It is more gurgling, coarse, and irregular, when situated in bronchial tubes of large size, because the bubbles are large and unequal. In the smaller order of bronchial tubes, on the other hand, it is more equal and minute. So we can perceive at once what kind of sound this rhonchus ought to have when in the trachea or in a cavity produced by disease. It is coarse and gurgling, in proportion to the size of the tube or cavity in which it is produced, and the freedom with which the air passes through the liquid; and, when presenting these conditions, the *cavernous rhonchus, gargouillement,* or mucous rhonchus of caverns, is one of the most remarkable and important signs discovered by auscultation. It would seem unnecessary to inquire further into the physical nature of the mucous rhonchus, were it not that the inquiry may enable us to distinguish some of its varieties from another rhonchus; which distinction is an object of considerable importance.

The sound of the mucous rhonchus depends on the bursting of successive bubbles of air which

pass through a liquid. A bubble is a portion of air contained by a thin film of liquid, which preserves its continuity by virtue of its attraction of aggregation; and the bursting of this bubble is the overcoming of the resistance of this power by some other, so that the air escapes. At the moment of its escape by the bursting of the film, its slight expansion communicates to the body of air, of which it is now become a part, an impulse which, if sufficiently forcible, produces a sound. Now this impulse will be forcible in proportion to the resistance offered by the film of liquid at the moment of its rupture, and will therefore be greatest when the bursting force is applied so quickly and suddenly that it meets with the full resistance of the newly formed film, undiminished by the extenuating power of gravitation.

Now the bubbles of the mucous rhonchus are both formed and burst by the respiratory movements driving air through the liquid in the bronchial canals; and they will therefore produce most sound in those bronchi through which the air passes most quickly. These are, of course, the bronchi of larger order. If the liquid be thin and watery, the bubbles pass, and burst in quick succession, with an irregular and more or less gurgling sound; but if it be viscid they are fewer in number, and may be carried

on in the tube some way before they burst; and the sound is therefore diffused, more regular, and rare. The quantity of liquid present in the bronchi may, in some measure, be estimated by the continuance of the rhonchus. If this accompany only the first part of inspiration and the end of expiration, the liquid must be scanty, for it only interferes with the air when the tubes are in their contracted state: But if the whole of the respiratory act, even to the acme of inspiration, is attended with the bubbling sound, then it must be apprehended that the quantity of liquid is considerable, and extends to the small bronchi.

A little liquid in the smaller bronchial tubes produces the *submucous rhonchus,* a kind in which the bubbles are fine and more crepitant; but they often intermit, and in a full breath are diminished to a slight roughness, accompanying the respiratory murmur.

The rhonchi of which I have yet spoken, with the exception of the submucous, are generally produced in bronchial ramifications, of above or about the size of a crow's quill; it is in those below these, or perhaps in the necks of the bunches of vesicles themselves that the *crepitant rhonchus* has its seat. This is likewise a bubbling rhonchus; but it is physically and pathologically different from all the others.

The sound is a gentle crepitation, uniform and continuing to the end of inspiration. It is compared by Laennec to the crepitation of salt by heat, and the resemblance is pretty exact when common grain salt of commerce is thrown on a heated iron. It may also be tolerably represented by rubbing transversely between the fingers and thumb a lock of one's own hair close to the ear. It is probable that in the cases in which the crepitating rhonchus is present, the calibre of the last bronchial division is so much diminished (by the interstitial effusion) that the air cannot pass through them, without raising the mucus, more or less viscid, into bubbles; which, being uniformly small, and bursting regularly, produce a continued succession of minute crepitations. The more viscid the mucus, the more distinct is the crepitant character of the rhonchus. It is perfectly so in the crepitant rhonchus of pneumonia. In pulmonary apoplexy and œdema, on the other hand, the liquid of the bronchi is thinner, and the rhonchus being less perfect in its crepitation, is accordingly called *subcrepitant.*

Thus the rhonchi give positive and direct indications of the state of the bronchial tubes; nor can these suffer materially without either altered secretion or change in calibre producing one or other of these rhonchi. Respiration thus

modified is generally more noisy than when free, and a rhonchus, particularly the sibilant or sonorous, may often be heard through the spongy texture of a whole lung. This does not, however, prevent the natural respiration of the healthy parts from being heard: for as long as two sounds differ in nature, the louder will not drown the weaker, unless the disproportion be great. For example, the sound of respiration may be heard although a much louder sibilant rhonchus accompany it: and a deep seated rhonchus crepitans can often be distinguished in spite of the respiratory murmur immediately below the stethoscope. We frequently hear a mixture of several rhonchi, occupying adjacent tubes; and it sometimes requires considerable attention to separate and recognize them.

The modification of respiration which constitutes cough, may often be consulted with advantage when the sounds produced in the ordinary respiratory act are doubtful or indistinct. Cough consists of a sudden and forcible expiration, succeeded by a deep but quick inspiration. Now as in this case the passage of the air is more forcible and perfect, the sounds produced by it must likewise be rendered more distinct than in common respiration; and not unfrequently cough may force

air through bronchi, too much obstructed to admit it by the common respiratory effort. The cough may, of course, be modified in the same way as common respiration; and may, therefore, be accompanied by the sibilant, sonorous, crepitant and mucous rhonchi. It discovers the existence of caverns more unequivocally than common respiration does, whether the caverns be empty and yield only the hollow resonance of air blowing in them, or whether, containing a liquid, they are the seat of the gurgling cavernous rhonchus.

The voice is another source of signs by which the auscultator may judge of the state of the lungs. The sound of the voice, although produced in the larynx, is propagated to the air in the trachea and bronchial tubes*, as out-

* I do not at all concur in M. Laennec's opinion, that the bronchial tree is a part of the instrument that originates the sound of the voice; for if it were so, disease would affect the voice in a very different manner from what we find to be the case. The hepatization of a lung, or its compression by a pleuritic effusion should in that case raise its tone to a treble. I have often known them to exist without changing it at all. It is true that large ulcerous excavations do sometimes render the voice deep and hollow; but this is because the want of breath prevents the patient from contracting the glottis sufficiently to produce more acute tones. To receive as much air as possible to fill the healthy cells, as well as the vast excavations in which it is wasted, the glottis either contracts only enough to produce a low bass note, or does not contract at all, and the patient then speaks in a whisper. I conceive that the trachea and bronchi, besides supplying the air for the production of the voice in the larynx, act something after the manner of a sounding board in musical instruments, reverberating and giving fulness to the voice, but not essentially producing or changing its diapason.

wardly it is communicated to that in the mouth and beyond it. Accordingly, if we listen with the stethoscope applied to the trachea or upper part of the sternum, we hear the voice through the instrument, and louder than by the other ear, inasmuch as the voice is outwardly diffused in a large space, but there confined within a narrow tube. If the stethoscope be applied to those parts of the chest under which pass bronchial tubes of considerable size, the voice will be heard there likewise, but it is not so loud, and its articulation is less distinct. Over smaller branches, the articulation is still further confused, and the voice is heard only in a diffused resonance. In the vesicular structure they are both lost, and over this a slight fremitus, which the voice produces throughout the chest, can alone be heard. The vocal resonance does not extend to the smaller bronchi, because they do not afford sufficient space for its vibrations; and also, because their less tense and more membranous tunics are ill adapted to reflect sound.

The vesicular texture is, as we have already seen, a very bad conductor of sound; hence it prevents the vocal resonance in the bronchi from being transmitted to the parietes of the chest; except in those parts where bronchi of some size pass close to the surface. It

therefore appears that different parts of the chest will present to the auscultator some varieties of this vocal resonance, and it is important that he should be acquainted with them.

When the stethoscope is applied to the larynx or trachea, the voice seems to enter the instrument as loudly as if the speaker's mouth were applied to it. This phenomenon scarcely ever exists to its full extent in any part of the chest unless in a state of disease; and it is therefore useful to distinguish between it and the natural bronchophony, which is to be heard under and near the upper part of the sternum, in the upper part of the axilla, and in the interscapular space. In these situations, the voice is generally louder than that which, proceeding from the mouth, strikes the other ear, but the words seem to be at the end of the tube, and not as in *laryngophony*, to pass through it into the ear. Such is the impression, and although it is illusory, and arises only from a difference in the body of sound, it should be attended to, as enabling us to make an important distinction.

The degree of vocal resonance in the chest differs considerably in different individuals, and the causes of this difference are not obscure. It is loudest, and most distinct and extensive in

those persons that are thin, and have a sharp treble voice; and if these circumstances exist in a great degree, the natural bronchophony may extend to the mesial parts of the scapular, infra-clavian, and mammary regions, whilst in the usual places it almost amounts to laryngophony. It is therefore remarkable in young subjects and in females. In those, on the other hand, whose chests are well clothed with muscles and fat, and whose voices are deep, the natural bronchophony is obscure and confined. The vibrations of deep notes cannot be extended to very narrow tubes, because there is not space for their play; and this explains the difference resulting from the tone of voice, and suggests that a change of tone in the same individual may considerably vary the bronchophonic resonance. In all other parts of the chest there is either no resonance, or only that slight vibratory fremitus or thrill that may likewise be felt on the application of the hand to the parietes during the exercise of the voice. This vibration, which accompanies deep tones more than others, is produced by the transmission of the sound, not through the bronchial tubes, but through the common substance of the lung, and is so slight as not to obscure other signs to any extent.

Disease may produce vocal resonance of

either kind, in parts where it does not naturally exist. In degree equal to laryngophony, this accidental resonance is called *perfect pectoriloquy;* and when it simulates the natural resonance under the sternum, it is *imperfect pectoriloquy.*

These symptoms are produced by unnatural cavities in the substance of the lung, to which the sound of the voice is propagated through the bronchi; and their presence is a certain proof of the existence of such cavities. When the stethoscope is applied to a part of the chest under which lies one of these cavities, the words which the patient utters seem to proceed from that spot; hence the term *pectoriloquy.* The distinction between perfect and imperfect pectoriloquy is, as in the case of natural resonance, whether the voice seems to traverse the tube, or to remain at the end; and the physical difference producing the two modifications, consists in the size and situation of the cavity. The most perfect pectoriloquy is produced in cavities of moderate size, which are situated near the surface of the lung, and freely communicate with a large bronchial tube. If the cavity be deep seated, or if its communication with the bronchi be imperfect, the resonance of the voice will not amount to perfect pectoriloquy. True pectoriloquy, produced by a ca-

vity, is generally abruptly circumscribed, so that its limits can be distinctly traced.

Pectoriloquy may be considered a certain indication of a cavity (almost always tubercular), whenever occurring in those parts of the chest where there is naturally no bronchial resonance. When it is heard in the other parts, it is more doubtful, but even there, if it be perfect, distinctly circumscribed, and heard so on one side only, it leaves very little room for doubt.

There is another way in which the vocal resonance may become a sign of disease. As we have noticed that bronchial respiration may become audible by the condensation of the intervening portion of vesicular tissue; so the same cause may transmit to the surface a bronchophony, which in the healthy state is confined by the surrounding ill-conducting tissue. Hence inflammation, œdema, tubercular and sanguineous infiltration are often attended with an accidental bronchophony. Accidental bronchophony frequently differs from that existing naturally in certain parts of the chest; but of this difference, and of that called œgophony I shall hereafter speak.

The sputa, in pulmonary diseases, although the signs which they give are not the directly physical effect of the lesions, yet furnish often such certain indications, and have frequently

such distinctive characters, that, when consulted together with the physical signs, they assist in a most essential manner in pointing out the nature of a disease. I have, therefore, in all my descriptions of the pathology and signs, referred to the character of the secretion of the bronchi, whenever expectoration presents it to our view.

Such is the general view that I would give of the physical signs of the state of the lungs; and as all the phenomena noticed have been found susceptible of explanation according to the laws of acoustics, we shall not meet with any greater difficulty when examining them more minutely as the signs of particular diseases. And by thus studying auscultation, not in the manner of vague and unguided experience, laborious to acquire, and burthensome to recollect, but, by a rational examination of its fundamental principles, and an application of these to individual cases, the student will be enabled to understand as well as know the physical signs of a healthy and diseased state, and to avail himself of these for the elucidation of diseases of the lungs, and for the suggestion of means for their cure.

Section III.—*On the Auscultation of the Heart.*

The signs that are produced by the action of the heart I have found neither so certain in

their indications, nor so intelligible in their causes as those which I have hitherto described; and I have, therefore, deemed it proper to postpone any attempt to include them within the plan of this work, until more extensive observation and study shall have supplied the desired intelligence. All that I shall at present introduce on the subject is a short exposition of a few signs which experience seems to have proved to be unequivocal.

The sound produced by muscular contraction was first noticed by Dr Wollaston. It may be exemplified by applying the palm of the hand to the ear, and at the same time moving the fingers. There is then heard a rumbling sound, like the rolling of a carriage on pavement, accompanied by a metallic tinkling. The tinkling is only a resonant echo produced in the internal meatus*; it is the rumbling sound that is produced by the contraction of the muscles, and is the same that in different degrees accompanies every instance of regular muscular action.

Without attempting the difficult task of explaining the manner in which sound is thus generated, we shall here content ourselves with the fact. It occurs in the contraction of the heart, and constitutes the sound of pulsation,

* See the Section on Pneumothorax.

which is heard in the præcordial region. This sound is double, and consists of a dull, slow noise, immediately followed by a short quick one, to which succeeds a short interval of silence. The first sound is produced by the contraction of the ventricles, and is synchronous with the pulse; the second is caused by the contraction of the auricles, and in the succeeding interval both are at rest. Laennec rates the average measure of these, in ordinary pulsations to be—the contraction of the ventricles lasts two-fourths; that of the auricles, one-fourth; and the interval of rest one-fourth of the whole period of a pulsation*.

The sound of pulsation is naturally loudest in the præcordium, that is, the space between the cartilages of the fourth and seventh ribs of the left side, and on the lower part of the sternum; the former part corresponding with the left, and the latter with the right side of the heart. In persons of middling stoutness, and healthy proportions, the sound scarcely extends beyond this region; in very fat persons it is still more limited; but in thin persons the pulsations may often be heard in other parts of the chest: and in

* Or, noted musically, a crotchet, a quaver, and a quaver rest in a bar. I think the auricular sound bears a shorter proportion; and we shall be more exact if, changing the measure, we note it a dotted crotchet, a quaver and a crotchet rest.

these cases the sound will diminish in the following order of parts; the left side from the axilla to the situation of the stomach; the right anterior and lateral regions; the left posterior regions; and lastly, where it is rarely heard, the right posterior regions. If there is any deviation from this order, it may be concluded that there is either something unusual about the heart producing the sound, or about the circumjacent organs transmitting it.

Besides the sound, there is an impulse or shock communicated by the stethoscope to the ear during the contraction of the ventricles. This impulse is felt only in the præcordial region, and if the sternum be short, sometimes in the epigastrium.

Such are the common phenomena discovered by auscultation in the healthy and moderate action of the heart. The following are the most remarkable effects produced by disease:

Simple dilatation increases the loudness and extent of the pulsations, but diminishes the impulse that accompanies them. Simple hypertrophy increases the impulse, and diminishes the sound of the pulsations. Hypertrophy and dilatation equally conjoined, or active aneurism, increase both the impulse and the sound in degree and in extent; but such an equal com-

bination seldom exists, and the prevailing disease is generally most apparent by its effects, to which some of the others may be superadded. Thus, in hypertrophy, with slight dilatation, the degree and extent of impulse may be increased, whilst the sound is diminished in degree, but more diffused in extent, &c. If any of these symptoms are heard more on one side of the præcordia than on the other, it is to be concluded that the disease lies chiefly in that side of the heart. The ventricles are the most usual seat of disease, but the auricles not unfrequently suffer also, and then the signs of derangement are more perceptible in the upper part of the præcordial region. When the auricles are dilated, their sound can often be heard as well under the clavicles as in the præcordia. A variety of irregularities may occur in the rythm of pulsation of the different parts of the heart.

Besides the sounds produced in the contraction of the auricles and ventricles, there sometimes occur concomitant sounds of a peculiar kind; apparently produced by some derangement in the action of the heart or large vessels. Such are the *murmur follis, murmur limæ, purring fremitus, &c.* These are not only heard in the region of the heart, but sometimes also along the course of large arteries. Laennec considered them to be of the nature of sounds

produced by muscular contraction, in these cases of spasmodic nature, affecting the heart or arteries in which the symptom is perceived. I am myself disposed to think that were we better acquainted with the laws of the production of sound, we might find that it may be excited by the motion of liquids, as well as by that of air, in or against solids of a particular form; and that we might find a more satisfactory explanation of the phenomena in question in the moving mass of blood being thrown into sonorous vibration by some modification in its course. Such a modification might be produced by thickening or irregularity in one of the valves of the heart, or by spasmodic action of some of the columnæ carneæ; by any obstacle in the calibre of an artery, &c.: and these causes might, as in the analogous case of air, render the passage of the blood sonorous, instead of, as it usually is, silent.

These are but conjectures; but the attempts of others to explain these phenomena have not assumed more certain form. I leave this subject, therefore, having introduced it here, only because, as in practical auscultation, the sounds produced by the heart will often, although not the specific object of examination, contrive to force themselves on the attention.

Having made ourselves acquainted with the general acoustic economy of the chest, we have

now to consider the manner in which we may practically avail ourselves of this knowledge in the auscultation of particular diseases.

All the acoustic phenomena of the chest may be heard by the simple application of the ear to its parietes. In this *immediate* method of auscultation, the sound is communicated through the parietes of the chest to the air in the hollow of the external ear and meatus, which being excluded from the access of all other sounds, receives, in unmodified intensity, every vibration that emanates from the chest. This method has the advantage of being simple, expeditious, and easily acquired; but it likewise has disadvantages, which render it less eligible than mediate auscultation. The direct application of the ear to the chest would in some cases be indelicate, and in others disgusting; and it is impracticable in some parts, as the axilla, and at the junction of the clavicle and humerus. Moreover, its indications are more equivocal than those obtained by the stethoscope; for, besides extraneous noises, produced by the friction of the hair and clothes, sounds of neighbouring parts, transmitted by the mastoid and zygomatic projections and other parts of the side of the head, in contact with the chest, are likewise sometimes heard in a confused manner, and obscure the immediate object of examination.

These objections, which Laennec has pointed out, I consider of sufficient weight to authorize our preference of the stethoscope in general practice. I have, nevertheless, not forsworn immediate auscultation; and in cases requiring little nicety of examination I often avail myself of the greater ease and celerity of this method, particularly in exploring the posterior parts of the chest, where the application of the stethoscope requires a somewhat tedious caution.

The stethoscope is an acoustic instrument employed in the auscultation of the chest. Although its construction is simple, and its application easy, yet I think we shall lose nothing by giving a little attention to analyze its physical office, and render intelligible the principles of its use. When we bring to the aid of our senses artificial instruments, we can neither perfect their construction, nor fully avail ourselves of their application, without a knowledge of the physical principles on which they assist our organs. No one can make a proper use of the miscroscope or telescope without understanding the laws of optics; and I hold that the easiest, the most agreeable, and the most certain road to a knowledge of stethoscopic phenomena, is through a study of acoustics.

The sounds heard by auscultation are seve-

ral in nature and in origin. Those of the voice and respiration are produced in air; that is, air is the vibrating medium; the sounds accompanying the motions of the heart, on the other hand, originate in a solid or liquid. This circumstance suggests the expediency of varying the conductor, according to the principle formerly pointed out, that a sound is most effectually transmitted by bodies of the same density as that in which it is produced. Again, some sounds, as that of respiration, are diffused and weak, and by concentration may be made more distinctly audible; while others, as those of the voice, are produced in a circumscribed spot, and are loud enough in themselves.

Now we shall find that all these differences may be met by a little modification of the same instrument. First, let us take a solid cylinder, which shall be excellent in conducting power, and particularly of density approaching to that of the contents of the chest, from which originate the sounds to be conducted. Nothing will better fulfil this end than wood, of light substance, but with considerable rigidity of longitudinal fibre. Deal, which on account of a modification of the same property, is pre-eminently useful in the construction of musical instruments, most completely answers to this character; and cedar possesses, in addition, the

advantage of elegance. With a solid cylinder of cedar, then, of convenient size, say ten or twelve inches long, and one inch and a half in diameter, we shall best be enabled to hear all those sounds that originate in solids. If this cylinder be perforated longitudinally through the centre, by a hole a quarter of an inch in diameter, this central canal will be well suited to transmit sounds that originate in air in circumscribed spots. To concentrate the diffused sounds, and to expedite the examination by making the stethoscope take in as large an extent of surface at a time as possible, this cylinder is hollowed out at one end into a conical cavity, the apex of which terminates in the central canal; so that all the sounds that enter the excavated end are reflected up into this canal, which conveys them to the ear. To reconvert this into a simply perforated cylinder, a perforated plug or stopper is adapted, of size and form exactly corresponding with the conical excavation. Thus contrived, the stethoscope is adapted to transmit sounds to the ear, either by conduction, along the fibres of the wood, or by reflection, through the central canal.

Such are the general principles of the construction of the stethoscope; for more particulars I must refer to the plate and its accompanying explanation.

We have had occasion to remark that auscultation with the stethoscope requires more practice and attention than auscultation with the naked ear; but this slight addition of trouble will be more than repaid by the greater distinctness and certainty of its indications. It does not suffice that the stethoscope should be resorted to only where delicacy forbids the practice of immediate auscultation; for it will be of little use to the person whose ear is not constantly accustomed to it. By using the stethoscope habitually, we obtain all the advantages of universal applicability and distinct indications, that it presents, without losing those of greater ease and celerity, which if particular instances should render them of paramount importance, are still open to us in immediate auscultation.

A little well-regulated practice in the use of the stethoscope is worth a volume of directions and cautions. By this the observing student will soon find how necessary it is to keep the instrument closely applied both to the chest of the patient and to his own ear, so that there be no communication between the interior of the tube and the external air; to hold it in such a manner, by the end near the chest, that no extraneous sound be communicated by friction of contiguous clothes or otherwise; to avoid pres-

sing so hard upon it as to produce pain, or interfere with the respiratory movements; to avoid too stooping or constrained a posture, which may cause tinnitus aurium, and render hearing obtuse; and to conduct his examination of the series of signs with as little fatigue to the patient as the case will permit.

The patient should not have over the chest more than a single garment of linen or cotton, and this should be kept smooth under the instrument. To explore the anterior and lateral regions the patient may be either seated on a chair, or lying near the edge of a bed: the examination of the back must be effected in the sitting posture with the body bent forwards. It is always the best plan to change sides in order to examine the opposite side of the chest, and not lean across, unless it be for the comparison of corresponding points on both sides, where it is important that the two impressions should succeed quickly to each other. The attentive student will soon find how far these precautions are necessary; and to what degree tact, furnished by experience, may supersede or modify them.

It is generally expedient to follow a particular order or method in conducting a physical examination of the chest. I usually begin with percussion, first on the clavicles, then on the ante-

rior parts of the chest, proceeding from above downwards; next on the lateral portions, beginning at the axilla, which are exposed by the patient raising his arm up to his head. The same parts are then examined, in like order, by the stethoscope, with due attention to the indications just obtained by percussion. For the percussion of the posterior part of the chest, the patient must sit with his head bowed forwards, and his arms crossed over his breast; and after due care in exercising percussion in this more obscure region, the easier test of ausculation may be practised.

For exploring the respiration, cough, and most of the rhonchi, the stethoscope should be used without its stopper. The signs of the voice are least equivocal, when heard with the stopper in, and to determine the extent of a rhonchus cavernosus, or crepitans, or of a bronchial respiration, it is often useful to resort to the instrument in this form. The heart is examined in the same manner; but when it is wished to hear the sound of pulsation without the impulse, the stopper should be taken out.

The physical examination of the chest, when adroitly and systematically conducted, is not nearly so tedious as might be imagined, and it is surprising with what ease and expedition it may be performed after some experience. A

few minutes will, in a majority of cases, suffice to furnish us with information far more certain than can be obtained in any other way; and, in cases of obscurity and difficulty, a much longer time devoted to it should not be considered as thrown away. But in all cases time should be deemed of much lower value than a true knowledge of the disease; and I hold it to be the duty of the conscientious physician to consider this, and the employment of curative measures founded upon it, as the paramount objects of his care.

"Prudens interrogatio dimidium est scientiæ;" and if its application to medicine does not, at the outset, always obtain the desired end, it is only through its means that we can hope to place medicine on a footing with other sciences, and render the art in any degree certain and effective.

PART II.

ON THE PHYSICAL SIGNS OF DISEASES OF THE LUNGS AND PLEURA.

Hitherto we have considered physical signs only with relation to the natural, or physical state, and the general pathology of the lungs; it now becomes our task to study the forms or characters that individual diseases present to the auscultator. To understand the physical signs of a disease, it is quite obvious that we must be acquainted with its pathological characters; for they are naturally inseparable: and I view it as not among the least advantages of physical examination, that it directs our attention through a confusing crowd of uncertain and equivocal symptoms of general derangement, to that substantial and primary lesion, which, if not the starting point of all, is that against which our practical efforts are the most required.

My object will be, not to enter into minute details of pathology and morbid anatomy; but as far as my own observations and those of others will enable me, to explain the general physical nature of the changes which, in individual

diseases, modify the acoustic relations of the lungs and pleura. I shall generally confine the text to pathology, properly so called, but I shall not omit to append, in form of notes, a description of the general morbid appearances found after death, by a comparison of which with the physical signs during life, the real nature of a disease is to be known. I begin with the diseases affecting the air tubes of the lungs.

CHAP. I. Section I.—*Bronchitis.*

The pathological cause of bronchitis, or pulmonary catarrh, is an inflammation and altered secretion of the mucous membrane of the bronchia. There are several varieties, and, perhaps, even species of this disease; but as they pass insensibly into each other, and as the physical signs of all are frequently combined in one, I shall comprehend in this section their general description.

Inflammation of the mucous membrane of the bronchi at first causes tumefaction and partial obstruction of their calibre. This partial obstruction, or constriction, when it occurs in individual points, modifies the passage of air through the bronchial tubes, and, producing vibrations, converts these tubes into instruments of music. If the whole periphery of a portion of a tube be tumified, the constriction is cir-

cular, and the air passing through it produces a whistling sound. This constitutes the *rhonchus sibilans*. If the tumefaction be unequal, so that the constricted portion preserves a flattened aperture, then a sound is produced after the manner of reed instruments, or, rather, of the horn or trumpet, by the rapid alternate compression and dilatation of the air passing between two vibrating laminæ, or surfaces. Such, I conceive, is the rationale of the *rhonchus sonorus*. The extent of the constriction, its situation, and the secretion lubricating the tube, will variously modify the note and tone. The larger bronchial tubes alone can produce deep or bass notes; but it is plain that they may also yield high ones. When a deep rhonchus sonorus is produced in a bronchus near the surface of the lung, it communicates a slight vibration to the corresponding paries of the thorax, which may be felt by the hand. This mechanical vibration is often perceived internally by the patient himself, although he does not hear the sound that produces it.

The sonorous and sibilant rhonchi, then, we find to be the first physical signs of pulmonary catarrh, and these are sometimes present before the cough becomes pronounced, and while the general symptoms only indicate a nasal coryza. As the inflammation attacks the larger

bronchial ramifications first, the rhonchus is usually grave, and frequently resembles the prolonged note of a violoncello, and sometimes the cooing of a dove.

After a while the inflamed membrane begins to secrete a thinnish saline tasted liquid, which at first mellows the sound of the rhonchi, but afterwards increasing, interrupts it by the formation of a bubble, which momentarily stops the vibrations, and then bursts. These bubbles increase in number as the secretion increases, and are at last produced in such a continuous succession, that the sound of the former rhonchi ceases, and is replaced by a new one produced by the successive formation and rupture of bubbles in the air tubes. This is the *mucous* or *bubbling rhonchus*. In the larger bronchi the mucous ronchus is composed of bubbles of unequal size, causing a gurgling sound; but in the smaller tubes the bubbles are more uniformly small, and the rhonchus may be called finer: they are, still, however, somewhat unequal; and even when in the extreme bronchi they can be distinguished to be liquid bubbles, and quite different from the uniform dry crepitation that constitutes the rhonchus crepitans. I have been minute in this description, because the distinction is important, as on it depends the diagnosis between an acute

pulmonary catarrh, and the first stage of pneumonia*.

The next modification in the rhonchus is produced by the thickening of the mucus contained in the air passages. This change, which usually diminishes the severity of the cough, is marked by the mucous rhonchus becoming drier and more sluggish, from the resistance opposed to the air in passing through the inspissated liquid. This resistance increases with the increasing spissitude of the mucus, and sometimes amounts to a complete obstruction of the tube; and in this case the sound of respiration ceases in the part supplied by it. More frequently, as the mucus becomes thick, its quantity is diminished, and then it only partially obstructs the tube. This straitening of the

* An ignorance of this distinction, and of the elements of the rhonchus crepitans, seems to have given rise to M. Andral's assertion, (Clin. Med. t. ii.) that this rhonchus may be produced by a simple acute bronchitis; an opinion, as M. Laennec remarks, supported by no observation; and, I may add, perhaps attributable to his having neglected the efficient clinical instructions of the great inventor of auscultation. Let not this expression of opinion be construed into a want of deference towards M. Andral. I have been witness of the devoted zeal of this able pathologist, I have watched his labours, and let me add, with sentiments of real gratitude, I have profited by his instructions; and were I required to name a man whose indefatigable industry is worthy of imitation, whose talented mind commands admiration, while his amiable deportment ensures esteem, and to the fruit of whose labour we may look for the advancement of medical science—the name of Andral would gladly be brought to my lips.

calibre may cause a rhonchus, and being soft and incapable of vibration itself, the sound produced is a whistle, in which air is the only vibrating body. Occasionally, however, at this period of the catarrh a ticking sound is heard, like that produced by the click wheel of a small clock. This is caused by a pellet of thick mucus at the orifice of a bronchial ramification, which acts like a loose valve, yielding, in successive jerks, to the air pressing for passage. A change in the force of respiration may much modify these several sounds. Thus, the forcible expiration and inspiration accompanying a cough may produce the clicking sound, or even the rhonchus sibilans, in a tube which, in ordinary respiration, is totally obstructed with mucus; it may convert the clicking into sibilation, and this into the simple sound of the passage of the air; the obstacles yielding, in all these cases, to the increased force of the passing air. It is therefore useful to avail ourselves of this simple mode in our examination; for, on desiring the patient to cough, the nature of the obstruction may frequently be made apparent by the momentary presence of one of the above signs.

The uncertainty in which the signs of auscultation sometimes leave us is completely removed by percussion. The sonorousness of the chest

is never sensibly impaired by catarrh; and, accordingly, the partial suspension of the respiration in a part of the chest, in this disease, cannot be erroneously ascribed to hepatization, or an effusion in the pleura.

The extent, as well as the seat of the catarrh, may be determined by the rhonchi. These are usually confined to a portion of one lung, and the disease is not dangerous; but if they occupy a large extent of both lungs, there may be considerable danger, the fever and dyspnœa being very great. Cases of this kind proving fatal are, in this country, erroneously considered peripneumonic. In some cases of continued fever the rhonchi indicate a catarrh in every part of the lungs: they are the sibilant, sonorous, and mucous rhonchi; and when thus mixed, Laennec used to designate them *rhonchus canorus*. Their presence may be considered a very unfavourable sign, and is seldom indicated by the cough or other symptoms, being, as it were, masked by the general affection of the system. In general, an acute catarrh is more dangerous in proportion to the age of the patient, and this probably depends on the different capability of dilatation in the pulmonary tissue; being greater in young subjects, it permits supplementary respiration in the healthy parts to supply the defect of the diseased. Be-

sides these, as in all diseases obstructing the respiratory function, the dyspnœa (and hence the danger,) will be great in proportion as this function is naturally or constitutionally active in the individual.

If the catarrh terminates in cure, the expectoration becomes thicker, and more concocted, as the ancients termed it. It is voided without irritation, in rounded, distinct pellets, consisting of an opake, greenish mucus. These and the cough diminish, and are confined to the morning, after waking, and a few times in the evening, and at last cease altogether.

But, if neglected, the catarrh may assume a chronic form. The cough and expectoration then continuing, the latter is usually at first of the same quality as at the termination of the acute stage, but it sometimes becomes diffluent, less viscid, and of a dirty brownish colour. After a while, it frequently is mixed with pus, and sometimes becomes completely purulent, presenting all varieties in odour and consistence that pus, from other sources, offers. To these are sometimes added shortness of breath, hectic fever, night sweats, emaciation, and, in short, all the rational symptoms of phthisis.

Deprived, as we are, of the means of diagnosis by these fallacious signs, let us endeavour to supply the defect by appealing to the phy-

sical indications. And here let me caution the young auscultator against too perfect a confidence in his examinations, and too hasty a conclusion from their results. As the diagnosis is important, so is it often difficult.

The symptoms heard by the ear in chronic catarrh, are the mucous rhonchus, in most of its varieties, shifting and intermitting from time to time, and, occasionally the sibilant, the presence of which is explained by the sputa; the sound of respiration, sometimes diminished, but usually unimpaired, or even puerile *; and the chest, on percussion, yields a clear sound. It will be perceived that all these signs are negative, and none of them characteristic of this modification of catarrh. It is therefore in the absence of the signs hereafter to be described, as

* The presence of the dyspnœa, in these cases where there is no obstacle to the entrance of air into the lungs, nay, where the puerile respiration shews it to be more perfect than usual, is ascribed by Laennec to an increased "*besoin de respirer.*" In the present instance, however, I see nothing more in this explanation than an expression of the fact. There is nothing in the state of the system that indicates the want of an increased activity in the respiratory function. The quantity and quality of the urine, and the other excretions, may be taken as pretty correct criteria of the extent of the chemical changes by respiration. I think that we must look rather to the change in the nature of the bronchial mucus for an explanation of the point in question. I have elsewhere (Trans. of Med. Chir. Soc. of Edin., vol. ii. p. 100.) pointed out an important part which this mucus performs in assisting the action of the air on the blood. It is easy to conceive how a diseased state may unfit it for this office, and impair the chemical function of respiration, however perfectly the mechanical part be performed.

peculiar to phthisis, that we must recognise the character of chronic catarrh. As, however, negative are weaker than positive proofs, so must they be multiplied to be rendered certain. If, after having repeatedly examined the patient, at different hours during several weeks, there are found no gurgling cavernous rhonchus, no cavernous respiration, no pectoriloquy, and no constant absence of the respiratory murmur, and of the sound on percussion, then, in spite of the general symptoms, we may, with tolerable certitude, pronounce the disease to be simply pulmonary catarrh, and a still further multiplication of examinations will remove all doubt *.

The long continuance of chronic catarrh may entail an organic change in the lung, which will almost destroy all distinction between its signs and those of tubercular phthisis. The bronchi, long the seat of chronic inflammation, and exposed to the straining influence of repeated paroxysms of cough, become hypertrophied and dilated.

I offer this explanation in preference to the

* This passage I have given nearly in the words of the illustrious discoverer of auscultation; yet, aware as he was of the attention required in the examination, and of the fallibility of a hasty judgment, I have more than once seen himself give proof in point by the failure of a premature diagnosis. If then, one, from knowledge and experience so profoundly acquainted with his subject, was, through inadvertency, led into error, how much more circumspect should they be who have not his experienced tact, and his talent for improving observation.

opinion of Laennec, that the bronchi are dilated by the accumulation of a thick mucus in them, for this reason—that the sign of such accumulation, namely, a suspension of the sound of respiration in the part, is scarcely ever observed in chronic catarrh; nay, the absence of this sign serves to distinguish the chronic from the acute disease. The dilatations are produced, I apprehend, in this manner: in the forcible expiration of coughing, the exit of the air is partially impeded by a coarctation of their calibre; the air thus confined, therefore, sustains the partial pressure of the respiratory forces, and in its turn presses the yielding parietes of the bronchi against those portions of the surrounding pulmonary tissue in which there is no obstruction to the exit. This pressure, frequently repeated on membranes already modified by disease, ends in producing a permanent dilatation. In accordance with this explanation, these dilatations are chiefly produced where the fits of coughing are very violent and convulsive, as in pertussis and catarrhus senilis.

These dilatations, at different points in the course of the tubes, form cavities of various sizes, still lined with the mucous membrane, which can be traced from the undilated portions of the tubes. It can be easily conceived how these cavities may give rise to pectoriloquy,

cavernous respiration, and most of the other phenomena by which a cavity from tubercular excavation is distinguished. The diagnosis is, perhaps, in these cases, of less importance, as art has little power over either form of organic disease; but, when on the subject of phthisis, I will endeavour to point out some means of discrimination, available at least to the experienced stethoscopist.

Dilatation of the bronchi, when extensive, may produce habitual dyspnœa, by obliterating portions of the pulmonary texture.

Section II.—*Pituitary Catarrh.*

The varieties of catarrh, which Laennec terms, from the nature of the expectoration, *pituitary* and *dry catarrh,* require to be noticed as far as they differ in their physical signs from mucous catarrhs.

In the pituitary catarrh, or humoral asthma, as some of our own practitioners have termed it, a thin, colourless, glary liquid, is secreted in abundance by the bronchial membrane. This flux comes on in paroxysms, attended with dyspnœa and cough, which are relieved by the expectoration of the liquid. It does not appear that the membrane becomes much tumified, unless occasionally by the co-existence of a slight degree of œdema. The dyspnœa and cough

are therefore to be ascribed to the quantity of fictitious secretion.

The respiratory murmur is weak, accompanied with the sonorous and sibilant rhonchi, occasionally modified by bubbles of the mucus, so as to imitate the chirrupping of birds, and sometimes heard distinctly with a liquid mucous rhonchus. When a slight œdema is present the humid crepitant rhonchus may also be distinguished, but this disappears in the interval with the other signs. The chest, on percussion, sounds well throughout the attack.

This catarrh may be confined to one or two paroxysms, or it may attack daily for months and even years. Like most other serous fluxes, it is very difficult to remove when once established, and frequently arises from the development of a number of miliary tubercles in the pulmonary tissue. Its long continuance produces that change in the mucous membrane that commonly accompanies, or is produced by, profuse watery discharges. This is a degree of atrophy which is sometimes attended with perfect pallidity, and sometimes with irregular striæ or patches of sanguineous injection.

From what I have seen of these cases, I am disposed to consider the prevailing evil to be a debility or want of tone in the vessels of the bronchial membranes, on account of which

the watery parts of the blood transude with little restraint and little modification. Inflammation may have been in the first instance the cause of this loss of tone in the vascular fibre; and even although it does not afterwards continue, phlogistic agents may aggravate the disease, by increasing the force of the circulation, by which a flow of liquid becomes directed to the weakened part.

Section III.—*Dry Catarrh.*

The *dry catarrh* of Laennec is, perhaps, in its general signs, more allied to asthma than to the preceding diseases. It consists in a sanguineous congestion in the membrane of the bronchi, which causes tumefaction, and partial or complete obstruction in their calibre. There is with this a scanty secretion of thick, semi-transparent, ash-coloured mucus, which arranges itself in globules, completing the obstruction of the tube.

The stethoscopic sign of this affection is, accordingly, a suspension of the sound of respiration in the part affected, while the corresponding part of the chest sounds perfectly well. Sometimes the obstruction is not quite complete, and then there may be a slight sibilant or a clicking rhonchus.

The severity of this affection depends entire-

ly on its extent, and this may vary from a degree not at all deranging the general health to one producing severe and oppressive asthma. Many persons, apparently in perfect health, only perhaps subject to some shortness of breath on exertion, present to the auscultator examples of the slightest degree, and these usually expectorate every morning a small portion of the pearly mucus that I have described. If the engorgement affect a longer extent of the bronchi, some degree of dyspnœa may be felt even when the person is at rest, particularly after meals. In a severer case the dyspnœa may last for several days, and is usually relieved by cough and expectoration of a small quantity of the same viscid mucus. These symptoms are still in proportion to the extent of suppression and obstruction of respiration observed by auscultation.

This disease not unfrequently terminates in the pituitary form; or rather, its paroxysms sometimes end in a watery expectoration, with a small proportion of the tough mucus in it. Like pituitary catarrh, it may have its first origin in an inflamed state of the mucous membrane; but from the natural duration of the symptoms, as well as from the appearance after death, I am disposed to consider its present cause rather as a passive congestion,

and consequently interrupted secretion, arising, perhaps, from deranged nervous influence, than an active inflammation.

Section IV.—*Pertussis, Croup, &c.*

The physical signs of *pertussis* do not materially differ from those of common catarrh, and are usually slight. In the intervals of cough, the respiratory murmur becomes indistinct in some points, and puerile in others; a sibilant or sonorous rhonchus is sometimes heard, and the sound of the chest, on percussion, is unimpaired. From this it may be concluded, that the violence of the cough does not depend entirely on the state of the mucous membrane of the air-passages, and an examination, during a fit of coughing, confirms this conclusion. If the ear is applied to the chest at this period, no rhonchus or respiratory sound is heard, except for a moment, between each cough; and during the sonorous back-draught all is silent within the chest. This absence of the respiratory sound, in an inspiration that seems so deep and forcible, is to be attributed to the admission of air being slow and scanty, on account of the spasmodic constriction of the glottis, by which, too, the hooping noise is caused. A spasm of the muscular fibres of the whole bronchial tract may also contribute to the exclusion of air from the

air-cells, but I cannot, with Laennec, consider this as the only cause.

I have had no opportunity of exploring the signs of *croup*, nor is it easy to predicate what they would be. Laennec gives a solitary example of a bronchial croup, in which the presence of an adventitious membrane caused a dry and tubular respiration, without the diffused, slightly crepitant sound so marked in children. This, with the sound of percussion unimpaired, if found constant, would (he suggests) be sufficiently distinctive of this form of the disease. The clearest physical sign of inflammatory tracheal croup is, certainly, the detachment and expectoration of the factitious membrane that is formed in the air-passages. But I have little doubt that, by attentive observation, a diagnosis might be drawn from the difference in the sound of the voice, and passage of the air through the trachea, and even from percussion upon it. Nor would it be unworthy of the inquiry: for the distinction between croups produced by a false membrane, by spasmodic contraction, by œdema of the glottis, by the pressure of an abscess, and other causes, involves important points in practice, a knowledge of which might have prevented many fatal accidents. A careful observer, having a knowledge of the laws of sound for a guide, might, by attention to this

subject, confer an important service on the healing art.

I do not believe that ulcers of the bronchi have any constant sign by which they can be distinguished. They excite a copious mucous secretion from the membrane, which is sometimes mixed with pus and blood. The presence of the same liquids in the bronchi occasions a mucous rhonchus. In these cases the local pain, excited particularly by exertions of the voice, is the most characteristic symptom.

For the diagnosis of polypous and other tumours in the bronchi, I must refer the reader to his own reflections; for as I am convinced that no one can become a good auscultator by the use of his ears and memory only, so do I maintain that by a knowledge of the properties of sound, and a happy generalization of its phenomena, an observer will be enabled to explain and appreciate not only all those signs that experience has hitherto discovered, but those that may also be revealed by future observation. Thus he who knows how the sonorous and sibilant rhonchi are produced, will perceive that a tumour pressing on a bronchus may likewise cause them. He will see, in a hæmorrhage simply bronchial, all the elements necessary to produce the mucous rhonchus, &c.

Section V.—*Spasmodic Asthma.*

Before the discovery of auscultation, this name was given to dyspnœa arising from many other causes than that to which pathological research, and a more perfect method of diagnosis, have now restricted it. Besides the real spasmodic disorder, dry catarrh, emphysema of the lungs, diseases of the heart, &c., sometimes affect the breathing in a manner so sudden, and for a period so transitory, that in defect of less equivocal signs, the dyspnœa has been ascribed to an irregular action of the bronchial muscles. Thus, a pathological state was supposed to prove the existence of bronchial muscles which anatomical research had never clearly discovered. A more perfect examination demonstrated to Reisseissen the anatomical point; and M. Laennec has, in a limited degree, established the assumed pathological state, in proving the occurrence of a purely spasmodic asthma.

During the paroxysm the chest sounds ill on percussion, and the respiratory murmur is indistinct, even on the most forcible respiration. But if the patient, after holding his breath a little while, be desired to breath again quietly, the spasm will be overcome as it were by surprise, and the entry of the air into the cells will be

heard in a clear, and sometimes puerile sound. This may be best effected in the manner recommended by Laennec, by desiring the patient to read aloud, or speak as many words as he conveniently can without taking breath, and then to breathe at his ease. But after one or two inspirations, the spasm regains its hold, and the respiration becomes as dull as ever. The diminution of the respiratory noise here, obviously proceeds from the obstruction opposed to the entry of air into the small bronchi and vesicles by the tomic contraction of their muscular fibres. By the same contraction the lungs are in a manner collapsed within the thoracic cavity, and the parietes of the chest, falling in with them, lose that sonorous elasticity produced by a fulness of aëreal contents*. The chest thus contracted to the size of the collapsed lungs, may be compared to a drum, the parchment of which is pulled in by transverse strings. The free vibration is thus checked by these unyielding frena. Conceiving, as I do, that the contraction of the bronchial muscles is a sufficient cause of the phenomena of asthma, I gladly discard Laennec's hypothesis of the active dilatation of the bronchi, unsupported as it is by physiological fact, and opposed to all we know of animal dynamics.

* See my observations on percussion, p. 17.

The dyspnœa produced by spasm of the bronchi is often of long continuance, and may, to a certain extent, become habitual. In such cases the system accommodates itself to the diminished supply of air, and the respiratory function is less called into action; but slight causes, either reproducing the want in the system, or increasing the spasm, will be sufficient to bring back the dyspnœa. Of the first class of causes are exertion, the sudden application of cold, &c.; of the second, depressing affections of the mind, and sympathetic irritations, produced by certain ingesta in the stomach and intestines. This second class includes usually those which originally produce the disease. I have seen a remarkable and exquisite case produced by the slow introduction of lead into the system, but such a form of saturnine neurosis is, I believe, rare.

This affection may be partial, affecting one lung only, or one more than the other, and is often complicated with partial dry catarrh, and pituitous or humoral asthma. The signs of these diseases will then be observed in some parts of the chest, while those pathognomic of the spasmodic affection will be heard elsewhere.

CHAP. II.

DISEASES AFFECTING THE TISSUE OF THE LUNGS.

SECTION I.—*Peripneumony.*

PERIPNEUMONY consists in an inflammation of the parenchyma of the lungs, and, according to the changes produced in the tissue, it is divided into three stages.

The first is that of simple inflammatory injection, in which the size of the blood vessels is increased, and a serum, more or less abundant, is effused into the interstitial tissue. Our knowledge of minute anatomy does not permit us to specify with certainty the exact and essential seat of this inflammation; but I am disposed, from a consideration of the signs, and the effects on the tissue, to refer it principally to the plexus of vessels and submucous tissue surrounding and uniting the minute extremities of the bronchi. It may, and usually does, extend to the mucous membrane of these extremities, and of the smaller bronchial tubes; but this is, strictly speaking, rather a bronchitis necessarily attendant on

the parenchymatous inflammation than a part of the pneumonia *.

In this stage of the inflammation, the distended vessels, and the serous effusion in the interstices, press on the minutest bronchial ramifications, and partially obstruct the ingress of air into the cells to which they lead; whilst the viscid secretion of the mucous membrane, simultaneously inflamed, filling the calibre of the tubes thus narrowed, only yields to the air in respiration forcing its way through it in successive bubbles. This bubbling passage of air through a viscid liquid, contained in an infinity of tubes of equally diminished calibre, causes that regular and equable crepitation which constitutes the true *rhonchus crepitans*. If the inflammatory infarctus be not so general as to prevent the air from entering without obstacle into many of the bronchial cells, then, besides the crepitant rhonchus, the natural sound of respiration will be heard. On the other hand, the inflammation increasing, and passing into the second stage, causes a total

* On dissection, the lung in this stage is found to be of a livid red colour, of various shades; it is increased in weight, and pits on pressure, but it is still somewhat crepitant, and usually floats in water. When cut into, it still presents its spongy structure, out of which exudes abundantly a spumous bloody serum. Its integral cohesion is diminished, for the texture may be easily broken down between the fingers. The mucous membrane of the small bronchi is of a deep red colour.

obstruction of the cells, and all sound of vesicular respiration, and even of crepitant rhonchus, ceases. The progress of the inflammation is, therefore, now marked by the gradual disparition of the crepitant rhonchus.

The second stage of peripneumony is that in which the lungs present that change in the tissue which is called by Laennec, hepatization *. This change consists in the effusion of a semi-solid albumen in the interstitial tissues, and which pressing on, and obliterating the cavities of air-cells and smaller bronchi, destroys the spongy texture of the lung, and converts it into a more or less solid mass. Such a condition of the air-cells precluding any further ingress of air, what stethoscopic signs can we have to indicate this stage of inflammation in the living body? Here still a consideration of the physical state of the organ will teach us to expect, *à priori*, the same phenomena that experience has revealed. We have already had occasion to observe that the healthy lung, from its being composed of conductors of very dif-

* *Ramollissement rouge* of Andral.—A hepatized lung presents the following characters after death: Externally it is of a deep red colour, which internally is mottled with a number of small light yellowish granular spots, with patches of whiter colour, marking the vessels, membranous septa, &c. not affected with the inflammation. It sinks in water, and is no longer crepitant, but breaks readily under the fingers, and may, by a slight pressure, be reduced to a reddish pulp.

ferent powers, (air, membrane and liquid) is a bad conductor of sound, and is, therefore, incapable of transmitting to its surface slight sounds, remote in the interior. But now that the tissue is rendered more uniformly dense by hepatization, it becomes a better conductor, and transmits a sound (usually unheard,) of the air passing to and fro in the larger bronchial ramifications. This is the *bronchial respiration* of Laennec and Andral; and specifically marks the second stage of pneumonic inflammation. This sound, when once heard, cannot be mistaken. It resembles that produced by blowing through a crow's quill, and is frequently so loud as almost to amount to a whistle. This sound, acute and defined, forms a remarkable contrast with the dull, diffused sigh of natural vesicular respiration.

Another nearly as characteristic sign is given by the voice. When the stethoscope, with its stopper in, is applied to the diseased part, the voice is heard to resound there in a tone modified, as if speaking through small tubes. The voice does not, as in pectoriloquy, appear to enter the tube of the instrument; and the sound of the voice is not heard in distinct words, but in notes of various continuance, not always synchronous with the words uttered by the mouth; and the intervals are often alter-

nated with what may be called whiffs of bronchial respiration.

It is obvious that the extent and intensity of these sounds must greatly depend on the number and size of the bronchial tubes in which they are heard. They are therefore most distinct when the hepatization occupies the summit or the neighbourhood of the root of the lung, and extends to the surface. On the other hand, when the surface or the centre alone is hepatized, these signs may be altogether wanting.

In the third stage the diseased lung becomes infiltrated with a purulent matter, which is generally consistent at first, but soon acquires the liquidity of common pus*. In this stage the bronchial respiration and vocal resonance usually cease, and are sometimes supplanted by a gurgling mucous rhonchus, indicating the presence of a liquid in the principal bronchial trunks.

In the rare case of the formation of an abscess in the hepatized lung, the passage of air through the liquid will be indicated by the

* This changes the colour of the diseased lung from the red of hepatization to discoloured yellow or brownish, which is frequently mottled with red portions in the second stage, and with the black pulmonary matter. This is called by Andral *ramollissement gris*. The tissue is quite impermeable to air, and of extreme friability, being reducible by slight pressure into a kind of purilage.

gurgling or cavernous rhonchus: and when the cavity has been emptied of the pus by expectoration, pectoriloquy and the cavernous respiration will be added to this sign.

Grangrene is also a rare termination of peripneumony. The gangrenous portion, being softened or ejected by expectoration, will produce a cavity which will be indicated by the usual signs of cavernous rhonchus or resonance. The distinctive physical sign of gangrene is the fœtid odour emitted from the diseased part in respiration*.

Thus far we have traced peripneumony in the changes in the pulmonary textures, as indicated by the stethoscope. The severity of the case may be judged from the extent of the disease, and the advances which it has made.

It is in the first stage of inflammatory injection that auscultation proves pre-eminently useful, in assuring us of the existence of a disease that no other symptoms could discover. The presence of the rhonchus crepitans may be taken as a warning to resort to energetic antiphlogistic measures, which in this stage will

* The anatomical characters of grangrene of the lung are various. The colour is sometimes like that of a simply engorged lung, with a greenish tint. Sometimes it presents a dark green, or an earth-brown aspect. In its progress the gangrene produces a softening and complete deliquescence of the pulmonary tissue: but the sphacelic fœtidity is the characteristic sign.

seldom fail in arresting its course. The disappearance of this sign, and sometimes the presence of the bronchial respiration and rhonchus, announce the increasing danger and progress of the disease, as they indicate its advance to the second stage. The diseased structure is, however still susceptible of a return to the healthy state, and the view which we have taken of the morbid anatomy of this stage suggests, in addition to means directed against the inflammatory orgasm, the important advantage with which sorbefacients may be used. I know of no symptom by which the third stage can be recognised during life; unless it be occasionally by the presence of the gurgling mucous rhonchus before mentioned. In this stage the disorganization has probably gone so far that the texture cannot be restored; and yet it is probable that even then recoveries have been brought about by the formation of abscess*. How far a cure may be effected by any other process we are not able to determine. Recovery from peripneumony, terminating in gangrene, is of still more dubious possibility. I know of no fact to warrant the supposition, but the extreme rarity of the case renders the matter of little importance.

The resolution or retrogression of peripneu-

* Laennec, Tom. I. p. 409.

monic inflammation, is attended by a succession of the same physical signs that marked its progress, but in an inverted order. Thus, in a spot where no sound of the ingress or egress of air has been heard, or perhaps only a bronchial respiration, a slight crepitant rhonchus begins to be distinguished at the end of each inspiration, apparently produced by the air again gaining a straitened admittance through a few of the bronchial tubes, whose calibres have been partially restored by the re-absorption of matter effused round their parietes. This sign increases in intensity as the resolution proceeds; the bronchophony and bronchial respiration are diminished as the lung re-acquires its spongy texture, and becomes a worse conductor of sound. After a while the natural respiratory murmur is heard mixed with the crepitant rhonchus; and as the texture becomes more permeable to the air, this increases as that diminishes, and the healthy function of the lung is thus gradually restored. But here again the signs obtained by auscultation are invaluable, as they alone indicate with certainty the absence of the disease. The dyspnœa may have been removed, the cough may have ceased, the expectoration may have become simply catarrhal, the pulse natural, and all febrile symptoms disappeared; and yet the auscultator detects the

lurking disease in the persistance of the crepitant rhonchus; and as long as this continues, a slight exposure to cold, or a trivial departure from antiphlogistic regimen may cause a relapse, which, in a subject already reduced by depletion, may be more difficult to cure than the original disease.

I have here described the access, progress, and cure of pneumonia in its general well-marked course; it will now be necessary to advert to certain varieties in the signs produced by situation, extent, and complication of the pneumonic imflammation.

When the inflammation occupies the central part of the lung, and particularly of the base, without extending to the surface, the experienced ear alone can distinguish the crepitant rhonchus in the first stage, and the bronchial respiration and resonance of the second, at a distance, through the natural sound of the respiration, which comes from the healthy portions at the surface. Whenever the inflammation occupies a considerable portion of the organ, the sound of the respiration in the healthy parts is much louder than usual, and is called *puerile* from its resemblance to the noisy respiration of children, or *supplementary* from its being increased to supply the defective entrance of air in the diseased parts. The intensity of this

supplementary respiration will depend, besides, on the extent of the disease, on the natural activity of the respiratory function, the want of breath, so different (as we have before remarked) in different individuals.

M. Andral has remarked, that in the complication of pneumonia with catarrh, the loud mucous rhonchus of the latter so completely obscures the rhonchus crepitans of the former disease, that this may escape detection; but I am inclined to agree with Laennec, that there are few cases in which the practised auscultator, assisted by the stethoscope, cannot distinguish the presence and seat of both symptoms*. The ear, by practice, acquires a great facility in separating, and listening to a single sound from amongst several others, perhaps superior in loudness. Nor let this appear surprising, when it is remembered that we are habitually accustomed, in the din of a city, to distinguish and be attentive to each of the multitude of sounds of various intensity that beset our ears†.

Percussion, though much inferior to auscul-

* When mixed with other rhonchi, the crepitant rhonchus is best distinguished at the end of each inspiration, that being the part of respiration the most purely vesicular.

† We effect this, I apprehend, by the voluntary tension or relaxation of the tympanum, by which it is made more susceptible of the vibration

tation in extent and certainty of its indications, is yet of great utility to confirm and assist it. In the first stage the chest often sounds well in the diseased part, or at least the diminution of the sound is doubtful, whilst the rhonchus crepitans unequivocally proclaims the presence of the inflammation. On passing to the second stage, however, the sound is evidently duller, and in the second and third stages becomes quite *mat*, and continues to be so until resolution brings it to its first stage again.

Percussion gives no indication when the inflammation is central; and it requires much practice to detect by it a small circumscribed inflammation on the surface. Its indications are always doubtful at the posterior and lateral margins of the lungs, on account of the vicinity of the abdominal viscera.

The peripneumonic inflammation modifies the secretion of the bronchial mucous mem-

of one particular sound, by being brought in unison or at least in harmony with it. Thus discordant sounds, or those not separated by harmonic intervals, are easily distinguished, but harmonic sounds being blended with each other, are with more difficulty separated, and this difficulty is in proportion to the perfection of the harmony; thus it is greatest with unison, next the octave, the fifth, the third, &c. This fact is of importance in auscultation, the indications of which may be obscured by similar extraneous sounds. Thus a tinnitus aurium in the auscultator, or the rustling of the clothes of the patient, may prevent the respiratory murmur from being distinguished, whilst a sibilant rhonchus may at the same time be heard with its usual force.

brane in a very remarkable manner. At the commencement of the disease there is frequently no expectoration, or it is simply catarrhal, being composed of a mucus of moderate tenacity; but as the crepitant rhonchus becomes marked, the sputa assume their characteristic form. They are semi-transparent, tenacious, and run together, forming one mass of a reddish yellow, or rusty tinge of various shades. As the disease advances, this tenacity increases. At first it does not much exceed that of the white of an egg, and when poured out, the sputa fall in glutinous strings, but at the height of the first stage they are frequently so viscid, that inverting the vessel, and even shaking it in this position, will not suffice to detach them from it. The same tenacious property imprisons in the mass a multitude of little air bubbles, which sometimes produce a spumous appearance. The colour may vary in numberless gradations from a light reddish or greenish yellow, to a deep orange or rusty hue. All these tints proceed from various proportions of blood intimately combined with the secretion of the bronchial membrane.

Quite different from these are the sanguinolent sputa that sometimes occur in catarrh, in which the blood appears in distinct striæ. The intimately combined tint, and the glutinous

viscidity of peripneumonic expectoration, give to it a character perfectly pathognomic, and sufficient in itself to prove the presence of the disease. Moreover, the degree of viscidity announces, with tolerable precision, the intensity of the inflammation; and whenever, after having become thinner in the course of cure, the sputa regain their former viscidity, a relapse into the disease is indicated. But although the presence of these sputa indicates with certainty the existence of pulmonic inflammation, we cannot draw an opposite conclusion from their absence. They rarely appear until the second or third day, sometimes not till later, and in some cases have not been observed at all. So also in the cure, they usually disappear, and the expectoration becomes simply catarrhal some time before the cessation of the rhonchus crepitans. They sometimes continue during the stage of hepatization, but more commonly become pituitous, or mucous and opake. In the third stage the expectoration sometimes consists of an opake mucus, occasionally mixed with pus; but more frequently, I think, it resembles a thin mucilage coloured with treacle. This peculiar form of the sputa first noticed by MM. Lerminier and Andral, M. Laennec considered merely fortuitous, and to proceed entirely from spongy and bleed-

ing gums, in cachectic subjects; but in this opinion I do not think he is borne out by experience. The appearance of such an expectoration must, at any rate, be viewed as a very unfavourable symptom.

Section II.—*Emphysema of the Lungs.*

Emphysema of the lungs consists in a general dilatation of the air vesicles, whereby the tissue is rendered coarser and less dense. To understand more fully the nature of the alteration, it will be requisite to study the manner in which it is produced.

In cases of chronic catarrh, particularly of the dry kind, the minute bronchial ramifications become so obstructed by the swelling of their membrane, or by the secretion of a viscid mucus, that the air can only be forced through them into the vesicles by a considerable effort. Now, as in ordinary respiration, the inspiration (a muscular effort,) is more forcible than the expiration, which is principally effected by the elastic force of the cartilages of the ribs, and the weight of the abdominal viscera, the former may prove sufficient to overcome the obstacle to the introduction of air into the vesicles, while the latter is inadequate to effect its expulsion. Successive portions of air, expanding by the increased temperature, are thus

introduced and incarcerated in the cells, which are thereby kept in a state of continual dilatation. This is, perhaps, a first and principal cause of the dilatation of the air-cells; but other causes co-operate, and other changes are produced, before the emphysema becomes permanent.

The forcible action of the expiratory muscles in coughing will exert a pressure on the dilated air-cells. This pressure may overcome the obstacle in the bronchi, expel the air, and restore the cells to their natural size. But the obstruction may have increased, and then the pressure will expand the cells in the direction of the adjacent yielding tissue. The dilated cells will thus encroach upon the adjoining healthy tissue, and cause its obliteration (a new obstruction in the bronchi), or the rupture of its cells. Add yet another cause, which may occasionally act, and we shall have found explanations enough of the frequent occurrence of a disease, the very existence of which has not, till of late, been suspected. In dry chronic catarrh, the general starting point of emphysema, small particles of viscid mucus form a kind of moveable obstruction, which, falling into a bronchial ramification, instantaneously and effectually plug up the tube. Now, suppose this to happen in a tube at the termination of an expiration; inspi-

ration takes place, but this pellet of mucus acts as a valve, preventing the entry of air into those cells supplied by this tube, the consequence is, that the air in the surrounding cells presses in to fill the vacuum, by dilating or rupturing their membranous tunics.

Such a variety of causes, acting and re-acting upon each other, tends to produce this organic derangement. How strikingly does this prove the exactitude and perfection with which the machine must act to preserve health, since so slight a deviation may entail such disorder; and how wonderful that the equilibrium is not more frequently lost! Besides the simple dilatation of the air vesicles, there appears to be sometimes an intervesicular emphysema, which causes the occlusion of some bronchial branches. To this, and to an increased rigidity of the tunics of the dilated cells, is to be ascribed the tense elasticity so remarkable in an emphysematous lung; hence, too, the incapacity of the lung to perform its function with effect. This incapacity is also manifested during life, by the absence or diminution of the respiratory sound in the part. This leads me to consider the physical signs of emphysema.

It not unfrequently happens that emphysema is present without producing any other signs than those of dry catarrh or asthma; namely,

a diminished sound of respiration, with slight sibilant or mucous rhonchus, and clear sound on percussion; and then the duration of the disease can alone serve as a distinction. But if the emphysema be more extensive, it will give to the chest an unnaturally rounded form, with increased intercostal spaces. If one lung only be affected, the corresponding side alone will present this appearance: it will be larger than the other, and emit a clearer sound on percussion. The stethoscope may discover from time to time a dry crepitant rhonchus of a peculiar kind, and which pretty closely resembles the sound produced by inflating forcibly the cellular membrane of meat. This sound is caused by the motion of air in the intervesicular texture, or particularly under the pleura, during the respiratory movements, and is clearly the same as that which may be produced by pressure on subcutaneous emphysema. More rarely, the sound resembles the friction of a pully, or that of two pieces of leather rubbed together, and this is usually confined to inspiration. I have sometimes heard these sounds produced not only by the action of respiration, but also by the impulse of the heart; which shows that they are not of the nature of other rhonchi.

The expectoration is usually like that of dry

catarrh, but often more liquid, and of a dirty grey colour.

It appears that emphysema of the lung, as it commences gradually, and proceeds slowly, is not attended with any immediate danger; but it produces an habitual dyspnœa, which incapacitates the body for exertion, and renders it obnoxious to serious, and even fatal effects from contingent pulmonary disease, which in a healthy lung might be borne with comparative impunity.

Interlobular emphysema rarely accompanies the last affection. More frequently it occurs separately, and is caused instantaneously by violent straining, or by some analogous exertion of the respiratory organs. As its name implies, it consists in an effusion of air into the cellular tissue, between the lobules composing the lobes of the lungs, and is strictly confined to it. This emphysema causes a slight elevation on the lung, from the interlobular spaces which it has made: and this elevation rubbing against the costal pleura in the motions of respiration, causes a strepitus, which I have already compared to that produced by rubbing together slowly and forcibly two pieces of leather. It is usually most perceptible at the end or acme of inspiration; but may accompany both inspiration and expiration, and then is sometimes heard

in such regular jerks, that it resembles the steps of a person mounting and descending a ladder. The impression conveyed to the ear is exactly that of a body rubbing along the ribs, rising in inspiration, and descending in expiration. The friction likewise often communicates a corresponding vibration in the thoracic parietes, which may be felt by the hand. The patient himself is sometimes sensible of a kind of cracking in his chest. Interlobular emphysema may produce at first some difficulty of breathing, but never to a serious extent, and is spontaneously cured in time by the gradual absorption of the air.

Section III—*Œdema of the Lungs.*

This is, properly speaking, a serous effusion in the interstitial tissue between the air-cells, and vascular rete, by which these are connected together. When contained, however, by membranes of such extreme tenuity, it is not surprizing that some serum should, by transudation, pass into the air-cells themselves*.

* Accordingly it is so found on examination after death. An œdematous lung does not collapse; on opening the chest, it feels weighty, and pits on pressure, but is still crepitant. Its vesicular texture is less perceptible than usual. When cut into, it exudes a clear, yellowish serum, scarcely frothy, which appears to proceed from all parts equally. It is, however, highly probable, that it is secreted in the interstitial texture, which is internal, and therefore serous, and not from the membrane of the air-cells, which is mucous.

Now this liquid, by swelling up the interstitial texture, so presses on, and partially obstructs the smaller bronchi, that the air passing through the liquid contained in them produces a kind of humid crepitation, like that heard on approaching the ear to a liquid in gentle effervescence, as bottled cider, or ale, when freshly poured out of the bottle. This is the subcrepitant rhonchus. It differs from the crepitant in the bubbles seeming less regular and more humid, but it must be considered different only in degree; for the two pass by insensible gradations into each other. The respiratory murmur that is heard with this rhonchus is feeble, particularly in comparison with the energetic action of the respiratory machine. The resonance of the chest on percussion is often not perceptibly diminished, but it is distinctly so where the dyspnœa is oppressive, and the œdema profuse and extensive. The expectoration is usually copious, consisting of a slightly viscid, colourless liquid. This, when present, will distinguish the disease from the first stage of peripneumony; but sometimes there is little or no expectoration, and then the diagnosis must be drawn from the general symptoms, as the other physical signs are so nearly the same.

Œdema of the lung is rarely idiopathic. It most frequently accompanies organic diseases

of the heart of long duration, and humoral catarrh, in which cases it is often the immediate cause of death. It sometimes succeeds to febrile affections, particularly the exanthemata, being the cause of the dyspnœa sometimes occurring after scarlatina, rubeola, &c.

There is one complication of œdema which renders it very difficult to recognise, namely, with emphysema of the lungs. When this is present the sound of respiration is so obscure that it is difficult to recognise any other sign than an occasional sibilation, whilst the sound on percussion is very good. A forcible inspiration after coughing, or retaining the breath for a while, will, however, frequently discover the disease, by rendering audible the subcrepitant rhonchus.

It is always important to be able to discover the presence of œdema in the lungs, for, although usually a consequence of other disease, it is always to be considered a principal object of treatment.

Section IV.—*Pulmonary Apoplexy or Hæmorrhage.*

This appears to consist in the effusion of blood into the parenchyma and vesicular structure of the lung. Whether this effusion is always in consequence of the rupture of vessels,

or is sometimes simply an hæmorrhagic exudation, has not been distinctly ascertained; but the former cause would seem better to explain the suddenness and quantity of the hæmorrhage, and the circumscribed form of the lesion. It is, however, highly probable that the textures are, in most cases, softened or altered by disease, before the rupture takes place.

The blood effused may coagulate before it reaches any large bronchial ramification, and, in that case, there will be no hæmoptoë, but more commonly the reverse happens; more or less blood is spit up, or, if in large quantity, more properly, as Laennec observes, vomited; for the discharge is produced by a convulsive action of the abdominal muscles, exactly after the manner of vomiting. At length, however, the hæmorrhage is checked by the formation of a coagulum, which, pervading completely a circumscribed portion of the pulmonary texture, constitutes the *hæmoptoic engorgement* of Laennec *.

When a point of the lung is thus affected, the respiratory murmur will, of course, be no longer

* These spots of pulmonary apoplexy are of a deep brown red colour; the coarser parts of the pulmonary structure alone can be distinguished in them, but even these partake of the same tinge. Unless they are very recent their consistence is firm, and they contain little or no serum. Sometimes there is an obvious detritus in the centre, formed of grumous blood alone, in which no texture can be traced.

heard there; and if the engorgement be of large size, there will be a corresponding dulness of sound on percussion, in that part of the chest. The compression of the tissue immediately around, and the presence of a bloody serum in the vesicles, proceeding from the coagulum, occasions a crepitant rhonchus, which is therefore heard around the spot where the respiration is inaudible. This symptom, however, seldom continues long after the commencement of the disease, but, once heard, it distinguishes it from a simple bronchial hæmorrhage.

During the hæmoptoë, as in the latter disease, the blood in the bronchi causes a bubbling rhonchus, which Laennec distinguishes from that produced by mucus in the bubbles bursting in more frequent succession. The stethoscopic symptoms with hæmoptoë are amply sufficient to indicate the nature of the disease; but when hæmoptoë is not present, the sputa and general symptoms must be referred to, to establish the diagnosis.

The extent of the hæmoptoic engorgement, rather than the quantity of blood brought up, indicate the degree of danger to be apprehended; for a large quantity of blood may pass through a small rupture in the pulmonary tissue, and unless this be so great as to threaten inanition, which is not often the case where

prompt measures are resorted to, the lesion is more of the nature of a simple wound than a change of structure. It is where the spots of hæmoptoic engorgement are numerous or large, that we have to apprehend some ulterior cause than a simple rupture, and whether this be a more frangible state of the pulmonary tissue, depending on the presence of miliary granulations and other precursors of tubercular formation, or be some modification peculiar to the disease called pulmonary apoplexy, it must be viewed as partaking in the danger of the general or constitutional alterations of tissue, that are very little within the control of medicine.

CHAP. III.

Section I.—*Pleurisy.*

Inflammation of the pleura could be recognised by no physical sign, if it were not attended by a serous effusion; and it is an interesting and satisfactory result of the researches of modern pathologists, that this is almost universally the case. It is interesting, as a point of general pathology, that inflammation of the serous membrane should necessarily produce an effusion; and it is satisfactory, because it furnishes us with the least fallible of all signs, whereon to found our diagnosis.

Exquisitely marked as this disease is described to occur, by the acute pain of the side, oppression of the breathing, hard pulse, decubitus on the affected side, cough, &c., there are few practitioners who have not proved the fallacy of each of these symptoms; and, as we shall presently point out, the auscultator finds but uncertainty in them all.

At the first attack, before there are any signs of effusion, if the pain be very acute, the sound of respiration will be somewhat impaired on the affected side. This is, however, merely

in consequence of the respiratory action being restrained on that side by the pain, and is equally observed in pleurodyne.

The secretion of liquid by the inflamed pleura commences from the beginning of the attack, and instead of being, as commonly supposed, a termination of pleurisy, it is a concomitant, or rather, a part of the disease; as the secretion from the bronchial mucous membrane is of catarrh. The first signs of this accumulation are obtained by percussion. The resonance of the chest is commonly diminished first in the inferior dorsal and lateral regions, corresponding to the base of the lung. As the effusion increases the dulness of sound gradually extends upwards, and becomes more pronounced*. Sometimes the transition from the dull to the

* The following are the appearances on dissection in different stages of an acute pleurisy:—The inflamed pleura presents many points or patches of a diffused redness, and a number of red vascular ramifications are likewise seen distributed over it. Different parts of the membrane are covered with coagulable lymph, and a serous or seropurulent, and sometimes sanguineous liquid is found in the cavity. This liquid, if scanty, occupies principally the lower and posterior part of the chest; but when abundant it envelopes the whole lung. The lung is found compressed, flaccid and less crepitant, in proportion to the quantity of liquid. Sometimes reduced to a size not greater than the hand of the subject, it is pushed by the effusion into a small space against the mediastinum and spinal column. In some cases the lung is bound by old adhesions and is then pushed in a different direction. When the adhesions are above, the lung is displaced upwards by the effusion; when the lower parts adhere (a very rare case,) the effusion occupies the upper part, and so on, the lung being always pressed against its points of attachment.

healthy sounding parts is so abrupt, that a horizontal line will exactly divide them, and this, when well marked, is a very characteristic sign. The sound of respiration likewise becomes more obscure as the liquid accumulates between the lungs and thoracic parietes; but the collection of liquid must be considerable before it becomes extinct.

Before this, however, another effect is produced which gives rise to its peculiar signs. The pressure of the effused liquid condenses the tissue of the lung, by which we have formerly seen it is rendered a better conductor of sound, and transmits noises, usually unheard, of the passage of air and the voice in the bronchi. But this bronchophony, and this sound of bronchial respiration, before they can reach the ear, must pass through the serous stratum between the pleuræ. How then do they effect this, and how are they affected by it? The fact is this: a respiration is usually heard becoming bronchial as the effusion increases up to a certain point, but then, as the bronchi themselves become pressed by a further increase it becomes faint, and at last ceases. If the stratum of liquid is thin the bronchophony traverses it, but, by throwing it into vibrations, is itself modified, rendered sharp and tremulous, and as if produced at the surface of the lung.

The voice, therefore, instead of being as from the mouth, or even simply diminutived, as in bronchophony, resembles the tremulous bleating of a goat or lamb. This modification of the voice M. Laennec therefore called ægophony. Its most distinctive mark is its tremulous or subsultory character. In bronchophony the natural pitch of the voice is sometimes raised, but in ægophony it is constantly and considerably so, and is thus rendered squeaking and wiry.

Now as this modification of bronchophony can be caused only by an effusion in the pleura, it may be regarded as a pathognomonic sign. But even in this case three conditions are necessary before it can be produced: 1. A certain condensation of the pulmonary tissue: 2. The presence of a thin stratum of liquid between the condensed lung and the thoracic parietes: 3. Such a proportion between the mass of this liquid and the pitch and strength of the vocal sounds, that it may be thrown into vibration by them. The necessity of this latter condition is shown in the fact that certain tones of the voice are ægophonic, and others not; some transmitted with only bronchophonic modification, and others changed to the sharp tremulous tone of ægophony. I think I could give an explanation of the change in the note or pitch of the voice in this instance, but as it

hinges on the power of different conductors, to modify vibrations in their passage through them, a subject hitherto unnoticed and unexplained, it would require consideration too abstract and minute for this place. I shall only remark that the tremulous or subsultory sound of the ægophonic voice is produced by successive undulations of the liquid, the result of an irregular transmission of the sonorous vibrations *.

It may be concluded from this account of the proximate or physical causes of ægophony, that this symptom cannot usually continue for any length of time. The liquid is either so much increased that the bronchi themselves become compressed; or, it is re-absorbed, so that the cause of ægophony is removed. The latter case is indicated by a return of the natural respiratory murmur in the part, and a sonorous resonance on percussion. In the former case, all sounds are lost, and the chest sounds uniformly dull, except in a small space close to the vertebral column, against which the lung is compressed. The effusion is sometimes so rapid that a few

* M. Laennec considers that another cause may contribute to the production of ægophony; namely, the flattening of the bronchi by the pressure of the effusion, whereby they are converted into little reed instruments, all set a piping by the sound of the voice. Besides that this explanation is unnecessary, I must object also that it is untenable. The reed of the bassoon and hautboy sounds only on the passage of *air* through it, and did the flattened bronchi represent it in this instance, the respiration, and not the voice, should make them sound.

hours duration of the disease may produce this state. There is, however, almost always one period at which the effusion unites the conditions necessary for the production of ægophony; and as the progress of the disease is slow or rapid, the duration of this period will be long or short. The situations in which it is most frequently heard may be included in a band about three inches broad, running from below the inferior margins of the scapula, in the direction of the ribs, to the sternum. It is most pure in the anterior and lateral parts, being often mixed with a natural bronchophony in the dorsal regions. Sometimes, however, it is heard in nearly every part of the affected side, the collection of fluid being but moderate. This universal ægophony never continues long, unless where the lung is prevented from collapsing before the increasing effusion, by old adhesions retaining it at a little distance from the costal pleura, in which case, after a time, the respiratory murmur returns, the pressure not being sufficient to exclude totally the air from the vesicles. Adhesions may, in other ways, modify the signs of pleurisy. Not unfrequently the apex or subclavicular lobe of the lung adheres closely to the costal pleura; an effusion can here never destroy the sound of respiration under the clavicle, and the same thing may occasionally happen in other

parts of the lung; the sound of the respiration remaining, however great the effusion in those spots, where an adhesion protects the lung from pressure.

It sometimes happens that the pleurisy and its effusion are quite partial, being confined to the tissues between the lobes, or to a part on the surface by adhesions. The accompanying pain and ægophony, will generally characterise these circumscribed pleurisies*. If these symptoms are absent, the diagnosis will be difficult, for the same partial absence of respiratory murmur and pectoral resonance, might result from other causes.

Whenever the effusion is abundant, and has been rapidly produced, the respiration on the healthy side will become puerile, or supplementary. Now as the sound of this respiration is sometimes heard on the diseased side, through the liquid, it will be necessary to guard against the error of mistaking it for a faint respiration on that side. On listening attentively to the sound, it will be easy to perceive that it increases in intensity as the ear approaches the healthy side, and that its loudness there will sufficiently explain its source. The continuance of a real,

* They most frequently occur in phthisical subjects, being excited sometimes by tubercles and sometimes by the bursting of a vomica into the pleura. The effusion is commonly purulent, and may, particularly when interlobular, be mistaken on dissection, for an abscess of the lung.

although faint, respiration, in a space of about three fingers breadth along the spinal column, corresponding with the compressed lung, will also furnish a standard of comparison, by which the other sound may be distinguished. Besides these tests, the ear, by practice, acquires the power to distinguish at once a sound faint by distance, and one faint in origin.

Another important physical sign, that indicates an abundant effusion, is an enlargement of the affected side. This, although when measured from the spinous process of a vertebra to the sternum, seldom exceeds an inch, or an inch and a half, is very obvious to the eye: an observer, placed opposite or behind the patient as he sits up, or stands naked, may detect the want of symmetry of even less than half an inch in extent.

Now, when the disease has arrived at this state, having been attended with more or less pain of side, dry cough, dyspnœa proportionate to the rapidity of its course, and the usual febrile symptoms of acute inflammation, all these symptoms may disappear; the pain and cough gone, the pulse nearly natural, the appetite returned, and the dyspnœa but slight, felt perhaps only on exertion; in short, the patient may appear convalescent, and yet, strange to say, one side of his chest is full of water! In this state, if he

be kept quiet, and limited to a strictly antiphlogistic regimen, there will be the symptoms of a slow and gradual absorption, which we shall presently describe; and the patient may in time be restored to real health. But if, relying on his sensations, and deceived by a false and illusory feeling of health, he returns to an active life, with a full and generous diet, the consequences may be disastrous. Either, the acute disease may be rekindled from its smothered state, excite an increase of circulation incompatible with the crippled state of the organs, and thus produce effusion in other parts, and consequent suffocation: or, the pleurisy may continue in a chronic form, perpetuating the effusion, becoming a part of the habit engendering tubercles, or other accidental productions. Hence organic disease will run its resistless and irremeable course, wearing down the strength by hectic, and wasting the body by atrophy, until life, scorning to dwell in such a tenure, ceases to hold it from its kindred earth.

Such may be the direful consequences of relying on fallacious general symptoms. Let us seek in auscultation and percussion, the beacon to warn us of the latent danger, and to guide us to the employment of means to avert it. The absorption of the fluid is indicated by

the gradual return of the respiratory murmur; first, in those points where it had persisted latest; afterwards, in others; and last of all in the parts where the accumulation had begun. It is very faint at first, but becomes stronger in time; but, generally, a very long period is required to bring it on a par with that of the healthy side: sometimes so slow is the absorption, that many months are required to dissipate a collection of fluid that was formed by a pleurisy of a few days duration. In other instances, however, the absorption is nearly as rapid as the effusion, and in these cases a returning ægophony also announces the diminution. When the effusion has remained long, the ægophony seldom returns; for, from the long continued pressure, the bronchi, in which it is produced, lose their elasticity, and do not immediately recover a sufficient calibre to cause that resonance of the voice which constitutes bronchophony. On account of the same loss of elasticity, and slow restoration of aereal texture in the lungs, the chest never recovers its sound on percussion proportionately to the return of the respiratory murmur.—Sometimes, for causes afterwards to be mentioned, the affected side remains dull as ever, after the complete absorption of the liquid. But when the complaint has been of short duration the

sonorousness returns perfectly, although more slowly than the respiratory murmur.

In the double pleurisy, where both sides are simultaneously affected (a very fatal form of the disease), the indications given by percussion are less certain; for both sides sounding equally ill, the standard of comparison is lost. But auscultation will assist us to detect the cause of the oppressing dyspnœa, which, unless the most energetic measures are employed, may soon end in suffocation.

The danger in acute pleurisy depends on the rapidity and quantity of the effusion. If the ægophony continues, it is a proof that the effusion is moderate, and nearly stationary, which portends an easy cure. In leucophlegmatic habits, the effusion is usually very abundant, and its absorption slow; hence these present the most unfavourable cases. After the system has sustained the immediate effects of the effusion, a transition to the insidious chronic state must be the source of apprehension, and this as long as there are no signs of a re-absorption. If, from the return of the respiratory murmur, or of ægophony, to a part in which it had ceased, it is found that the diminution has commenced; then if no fresh excitation be applied, a gradual cure may be expected with confidence. But if after the cessation of the acute symptoms, the

absorption not having begun, or being arrested in its course, a slight fever rekindles, generally with evening exacerbations, attended with more or less cough and mucous or mucopurulent expectoration, then it is to be feared that the disease has taken the inveterate and intractable habits of the chronic disease, and the prognosis becomes so much the more unfavourable.

Let us bestow some attention on the changes that accompany the different terminations of pleurisy.

The serous effusion is not the only product of the pleuritic inflammation, although it is the only one that is indicated by physical signs. A plastic or coagulable lymph is at the same time exsuded by the inflamed membrane, and becomes the basis of a variety of products. Now as this takes in different forms, according to the modifications of inflammation, it will be useful to enquire whether this variety depends on unknown causes, or whether it be not referrible to some known pathological law.

The secretory action of the vessels of a part in health is twofold; 1. the *action of assimilation or nutrition,* by which the tissue is perpetuated in its kind, and preserved notwithstanding the operation of an opposite power, absorption; and 2. *external secretion,* or action by which some parts of the blood are separated from or out

of the tissue. The first is the more perfect act of living structure, varying in the different elementary textures of the body, but always preserving their individual identity. The latter, in its simplest kind, is little more than a mechanical transudation of the more watery parts of the blood, such is the secretion of serous and cellular membrane; but when modified by complicated structure and vital* energy, the product of this secretion is often more peculiar and characteristic than that of the assimilatory of

* Shall I say *nervous?* So the analytic experiments of Mr. Brodie, Dr. Philip, &c. seem to indicate; but I think with Dr. Alison, not yet in a manner sufficiently decisive. To clear this matter labour and thought yet are wanted.

"Nil sine magno,
"Vita labore dedit mortalibus."

Still let us guard against the error of considering the term vital as explanatory, or as implying an ultimate thing, not to be analyzed or resolved into simpler. I would rather employ it as a generic term, comprehending not only the unknown power operating in the living body, and *hitherto* unexplained by any physical laws; but also the operation of physical laws through a *mechanism* or *organization*, peculiar to living bodies. The progress of physiology, which has already transferred many living actions from the former to the latter class, may ultimately penetrate the mist that obscures the remaining *terra incognita* of vitality, and find there nothing so unearthly as not to be reducible to the chart of animal physics. Be it understood, I speak here of organic actions only. The sensorial or animal powers require a distinct consideration, and then appear like the properties of matter, too simple for analysis; like geometrical lines or points, too elementary to admit of definition. Any explanation, therefore, applied to these can be but sophistry, for if mental, it would be to argue in a circle, if material, *ignotum in ignotius.*

"Nec scire fas est omnia."

the same texture: this is instanced in the kidneys, liver, and other excretory organs.

Such are the healthy secretory functions of all tissues. Now let the vascular action of the part be increased in different degrees. The first effect will be, an increase in the external secretion; in great measure the mechanical result of an augmented flow of blood. The same degree of increase will also in time affect the slower process of nutrition, causing simple hypertrophy, or increase of natural substance. These changes, although frequently produced by disease, do not differ in nature from the physiological phenomenon of growth. On a further increase of vascular action, however, the effect becomes more peculiar to a pathological state. Besides a greater change in the external secretion, the tissue itself becomes more or less thickened and altered, being at first softened, but if the cause continue long, afterwards indurated; the one being the effect of acute, and the other of chronic inflammation. Now what are these but modifications of the nutritive or assimilatory secretion? It is augmented; new matter is deposited in the tissue, first in a liquid state, diminishing its molecular cohesion; hence the softening: the cause continuing, and no re-absorption taking place, the new matter, according to its accustomed process, becomes

solid, and uniting in firm molecular adhesion with the tissue, increases its solid substance: hence the induration. Now this change of nutrition differs from simple hypertrophy, or growth, in the more condensed arrangement of the solid particles, and presents the first instance of structural disease, peculiarly pathological. Let the vascular action be yet increased further, there will be an overflow of the nutritive secretion, which, no longer confined to the texture, will now become external, and will be effused with the liquid secretion, in forms varying according to the degree of inflammation, and the changes already induced. The matter thus effused is albumen or fibrine, the coagulable parts of the blood; for as Berzelius, and Prevost and Dumas have shewn, these are but varieties of the same substance. Enough in the abstract:—now let us apply these general pathological laws to the case before us.

The pleura is a simple lamina of membrane, so thin, and of context so simple, that it is scarcely susceptible of thickening. As soon, therefore, as it is sufficiently inflamed to augment the nutritive secretion of the vessels, this soon overflows outwardly; and with the increased external, or serous exhalation, an *albuminous exsudation* takes place on the surface of the membrane. This exsudation is the basis

of all the factitious membranes, accidental productions, and diseased formations found in the cavities of the pleura*. Let us now examine how these varied products result from different degrees or modifications of inflammatory action.

In the acute form of pleurisy, the inflammatory orgasm is intense, and the nutritive secretion increased to the utmost; the albuminous exsudation is abundant, easily organizable, and capable of as high vitality as the membrane that secreted it. In fact, the vessels under the influence of inflammation produce, at once, what in health they are required to do slowly, and to supply decay—the materials of their own membrane. The simultaneous exhalation of serum separates the lymph thus thrown out into thin laminæ, and these becoming vascular, in the manner described by Sir Everard Home,

* I consider inflammation of a serous membrane to be the most simple of any. In more complicated structures, its varied effects arise from the difference of structure. Why does an inflamed mucous membrane throw out pus and not coagulable lymph? The reason is obvious. Its internal or nutritive secretion being increased beyond the degree causing simple hypertrophy, an interstitial effusion takes place, which causes a thickening of the membrane, and mechanically restrains its further effusion, so that the inflammatory orgasm continues; the external overflow of the nutritive matter will be in a disintegrated form, in separate particles, or globules, and far less susceptible of consolidation and organization. It would be easy to trace other varieties to analogous differences of structure; but the "certi denique fines" of this work forbid my taking such an excursion.

are further perfected into a number of new serous membranes, forming bands of adhesion between the pleuræ that produced them. These adhesions, the result of a frankly acute inflammation, are so exceedingly common, that it is rare to open a body without them. Being loose and mobile, they appear to produce little or no inconvenience or impediment to the respiratory motions.

It is different with another modification of the disease, which Laennec has denominated hæmorrhagic pleurisy. The albuminous effusion has then mixed with it more or less of the colouring matter of the blood. Now this impedes the process of organization, for the colouring matter in no way contributes to the formation of texture, and must be absorbed before the organization can be perfected. As the new product is of slow generation, so is its vitality of a lower degree; the excitation or orgasm of the vessels having been much diminished before it could be extended to the new sphere of action, the matrix of the new tissue. Hence there is produced not a new serous membrane, but one of a fibrous or fibro-cartilaginous texture, of inferior vitality, and wanting the soft and yielding mobility of the serous tissue; and this character in a less degree extends to adhesions formed by pleurisies, slow in progress,

that are not hæmorrhagic. Now, what will be the consequences of the formation of such a membrane? The lung will be bound down by it in the compressed state to which it has been reduced by the accumulation of the liquid effusion, which, in these cases, is always abundant and of long duration. The liquid being diminished by absorption, the lung, thus restrained, can but partially recover its expanded state; and one of two things must take place to fill the vacuum left by the retroceding effusion: either, the thoracic parietes will be drawn inwards into close contact with the diminished lung; or, the place of the effusion will be occupied by an aeriform exhalation. The first is the most common case, and constitutes the contraction of the chest so well described by Laennec.

In a subject thus affected, the contraction is discovered at once by the eye, and may be proved by a measurement, compared with the healthy side. The ribs are drawn closer together, the shoulder lower, and the muscles appear less prominent than on the healthy side. When the contraction is considerable, the person leans a little to the affected side, which causes something like a limping in his gait. The chest having on this side lost the elastic freedom of equal tension, is no longer resonant

on percussion. The sound of respiration is, however, preserved with a diminished intensity, except in the inferior parts, where it is generally obliterated*.

The general symptoms of hæmorrhagic pleurisy are frequently not well marked, and it is always very long in its progress towards cure. Several months are required for the dispersion of the effusion, and the full contraction of the chest. This being effected, the new fibro-cartilaginous membranes of the costal and pulmonary pleuræ come into contact, and as they are not, as serous surfaces, adapted for mutual friction, by an augmentation of the nutritive secretion of their vessels, a gelatinous matter is deposited between them, which, in time, becomes a bond of union, consisting of fibro-cartilage of lower vitality, or even of real cartilage†.

* This is, of course, because the inferior lobes of the lungs are so much compressed that they are perfectly impermeable to the air. They appear, on dissection, flaccid, like a uniform muscular tissue, sometimes red or livid, and sometimes of a light fawn colour.

† It is in this middle lamina that the ossific process frequently operates. In one instance I have seen this exemplified in the formation of a bony lamina, of considerable thickness on each side of the lung, and covering it like a cuirass. The natural tendency of cartilage to ossification, and the acceleration of this process by inflammation, so sagaciously pointed out and beautifully described by M. Andral, in his works and lectures, may be comprehended in the view I have attempted to give of the effects of increased determination of blood on the different secretory powers of vessels.

This may be considered a cure for persons thus affected, although they have a shorter breath than others, labour under no habitual dyspnœa. Catarrhs, and other affections impeding respiration, will be more severe in their effects on such subjects, as they have less room for abridgement of the function. On the other hand, they may be considered more exempt from pleuritic attacks in future, as the gluing together of the pleuræ renders the pleuritic effusion impossible on that side.

I have mentioned another event of the confinement of the lung by a fibro-cartilaginous membrane, namely, the filling up the space left by the effusion with an aeriform exhalation. This mode of termination, although not noticed by Laennec or any other author, has fallen under my own observation; and, I believe, is likely to occur in most cases where the hæmorrhagic pleurisy is partial, or confined by ancient adhesions. A partial cavity is formed by the effusion, which, on its re-absorption, cannot be filled by any contraction of the thoracic parietes. It therefore becomes filled with gases with which the animal fluids abound. This case is different, it must be remarked, from those described by Laennec, in which the pneumothorax is, as it were, active, and in which the gases themselves (perhaps evolved

by the decomposition of the pleuritic effusion), and not a fibro-cartilaginous membrane, continue to keep down, by pressure, the reduced lung. The pneumothorax is here the disease, but, in the former case, a consequence of the cure. I shall return to these cases afterwards.

Let us now examine the effect of a third degree or modification of pleuritic inflammation, constituting what is called *chronic pleurisy*. The inflammatory excitation, although sufficient to cause an overflow of the nutritive secretion, is not adequate to extend itself by vascular communication with the organizable materials thus thrown out: these being, therefore, retained by no bond of union, become, in succession, detached from the pleura in small flakes, and mixing in great abundance with the serous effusion, constitute the liquid of *empyema*.

Empyema, then, is produced by a chronic inflammation of the pleura; and is neither the result of the suppuration of the lung, as was formerly supposed, nor, in fact, is it formed by real pus. The difference is, however, less than this description would at first suggest, since both consist of albuminous globules floating in a serum; but in the liquid of empyema the globules are united in small flakes, and the

serum is more abundant, both of which peculiarities may be explained by the structure of the membrane that secretes it. In its physical signs, chronic pleurisy does not materially differ from the acute disease. The effusion is recognised by the dull sound on percussion, total absence of the respiratory murmur, and the enlargement of the affected side. Ægophony is rarely present; for generally the disease is either engrafted on an acute one; or, if idiopathically chronic, commenced so insidiously, that the effusion has exceeded the ægophonic degree before it attracts attention. The geral symptoms are usually such as practitioners in this country would consider indicatory of phthisis, and joined, as it usually is, with chronic catarrh, and sometimes purulent expectoration, it is impossible, without the aid of the physical signs, to distinguish between the two diseases.

In fatal cases, which Laennec rates at the proportion of a half, the last stage presents complications with peritonic and gastric disorders, and the patient dies in a state of extreme emaciation. Where the predisposition exists, chronic pleurisy often excites the secretion of tubercular matter, and perhaps also the formation of miliary tubercles in the pulmonary tissue. It is by such peculiar predispositions

or diatheses *, that the products of inflammation or increased vascular action are changed from new membranes and pus, to scirrhous, cerebriform, and tubercular formations. An increase in the nutritive secretion must be the basis of all these new productions; the manner in which this is modified by peculiar constitution is involved in the mystery of secretion; but the increase is certain. Now, for an increased secretion, there must be an increased determination of blood. Does this amount to inflammation? I answer by another question, which proves the logomacheia—What is inflammation?

Section II.—*Pleuropneumonia.*

It very frequently happens that pneumonia is attended with some inflammation of the pleura; and again, in pleurisy, there is often an extension of inflammation to the pulmonary parenchyma. This complication, instead of presenting a more aggravated case, rather, as M. Laennec remarks, mitigates the severity of both diseases; and this from a cause purely

* Flimsy and unmeaning words these, and yet necessary in our ignorance. The study of pathology has done much, and will do more for the improvement of medical science; but when shall that propitious day come, when the art of medicine shall cease to be a hovel of disjointed material? when—with foundation in firm nature, laid, built and cemented by science—shall it really prove the temple of Hygeia, a certain refuge from the tempest of disease?

mechanical. The pressure exerted by the pleuritic effusion moderates the inflammatory action in the lung; and, again, the lung, in some degree consolidated by the inflammatory process, not yielding to the encroaching effusion, sets limits to its accumulation. If, however, the intensity of a pneumonia is diminished by a cotemporaneous pleurisy, its duration is probably prolonged; for the process of resolution is always much slower in this than in the simple case. This is because the interstitial effusion is more solid, and less mixed with the serous exhalation produced by common inflammation, and which cannot but assist in the discussion of the denser products. On the other hand a pleurisy, coinciding with pneumony, will be of easier and speedier cure, inasmuch as the effusion is less abundant*.

The signs of pleuropneumony are, as may be expected, a combination of the signs of pneumonia and pleurisy. The crepitant rhonchus will be heard in all those parts of the lung, affected with inflammation, that are not pushed

* It is by inflammation, thus modified by pressure, that is produced that change in the lung, called by Laennec carnification. The tissue of the lung in this state has the colour and consistence of flesh, is no longer crepitant, and presents no traces of the vesicular structure. The suppurative stage is scarcely ever observed in it; M. Laennec has, in a few instances, remarked a kind of yellow carnification, perhaps a modification of the third stage.

away too far by the effusion. It may, therefore, be looked for at the root of the lung, and all round the middle regions of the thorax; and it may sometimes be heard in other parts. Again, the ægophony, the sign of the pleurisy, is commonly to be found at the root of the lung; and here it is generally combined with a noisy bronchophony proceeding from the large bronchial ramifications. This combination of ægophony and bronchophony M. Laennec compares to the squeaking voice of punchinello. The comparison is pretty exact, but not quite adequate to represent the impression. Besides the punchinello voice, composed of a buzz and a squeak, there is a tremulous or vibratory character in the sound, which seems alternately to approach and recede from the ear in sudden jerks. These signs, as they usually continue throughout the disease, render it very easy of recognition.

The occurrence of extensive peripneumony with copious pleuritic effusion is comparatively rare. It is more common that one disease has the predominance, and is attended only with a slight degree of the other. Inflammation occupying part of a lung, is frequently extended outwardly to the pleura, which becomes covered at that point with a thin coating of coagulable lymph, and secretes a seropurulent

liquid; and it is a remarkable fact that lymph is often effused also by the corresponding point of the costal pleura, the inflammation being propagated by contiguity*. The ægophony on the one hand, and the crepitant rhonchus on the other, will easily distinguish such a case. But if the whole of a lung be inflamed, and converted into a solid mass, although there be no liquid effusion in the pleura, the only sign that will distinguish the case from that of a copious pleuritic effusion, is a more noisy and almost pectoriloquous bronchophony at the root of the lung. But if this case has been observed in its progress, the characters of the first stage of pneumonia must have sufficiently announced its nature.

Pleurisy is sometimes accompanied by a circumscribed, and even lobular pneumonia, modified in the manner above described. This inflammation will generally be announced in some corresponding point of the chest, where the

* This is one instance, out of many of the same kind, which seem to indicate that the assimilatory power of inflammation, or perhaps, even its proximate cause, is of a nature more mobile and subtle than can be explained from any known modification of vascular action. The Broussaians resort to the term *irritation*, less exceptionable only because more vague: "Res non verba quæso." These, and many other phenomena seem to me to approximate certain vital properties to electrical or galvanic influence. Such an explanation must, however, yet be in the uncertainty of remote prospect; we have not yet arrived at the ground of its proofs.

stratum of pleuritic effusion is thin, by the crepitant rhonchus. In short, it is easy, from a knowledge of the pathology of pleuropneumonia, to predicate all the varieties in its physical signs, as they indicate more of a pleuritic or of a pulmonary inflammation.

Section III.—*Hydrothorax.*

It was formerly the common opinion, and is even now believed by many, that idiopathic hydrothorax is a very common disease, producing a formidable array of symptoms, and often causing death by suffocation. In these late years the erroneousness of this opinion has been shewn; on the one hand, by the study of pathological anatomy, which has discovered, in the supposed cases of simple hydrothorax, extensive organic causes of disease, without any effusion; and, on the other hand, by auscultation and percussion, which have not only proved the same during life, but have likewise taught us that hydrothorax, when it does exist, can have but a very small share in producing the symptoms that have hitherto been ascribed to it.

In fact, simple and idiopathic hydrothorax, or dropsy of the pleura, causes but one general symptom, dyspnœa, and this to a very slight degree, unless the dropsical effusion be very

abundant, and of sudden formation. A symptomatic hydrothorax is sometimes produced a short time before the fatal termination of organic diseases of the viscera; and, excepting dyspnœa, these cases are attended with no symptom, that is not frequently present in the same diseases, terminating without hydrothorax. In short, I need only refer to the history that I have given of pleurisy, to shew how very slight and uncertain are the symptoms of even an abundant effusion in the pleural cavity. The physical signs are the only certain tests of its presence; and, in the present instance, they will be equally infallible: I need scarcely observe, that they do not differ from those of the pleuritic effusion. An idiopathic hydrothorax is to be distinguished from this latter case by the absence of fever and other constitutional symptoms, peculiar to pleurisy.

Symptomatic hydrothorax will combine with the common signs of pleuritic effusion, those of whatever organic disease it is the consequence; and this will generally be found to be some lesion of the circulatory apparatus, by which its function is extensively impeded. Laennec states that it scarcely ever supervenes earlier than a few days before the fatal termination of such diseases, and may, therefore be considered the immediate harbinger

of death, the agony of which it increases by dyspnœa.

Section IV.—*Hæmothorax.*

Besides in the case of hæmorrhagic pleurisy, formerly mentioned, blood may be effused into the sac of the pleura from a wound, by the rupture of an aneurism, by pulmonary apoplexy, and by a passive transudation. As long as this blood remains liquid, it must produce the same effects as we have described of serum in the same situation. When coagulated, it would render obtuse the sound of percussion, and diminish the respiratory murmur in proportion to its quantity; and might, perhaps, produce bronchophony, but not ægophony, for that, as we have seen, is the result only of a liquid effusion. Some, therefore, of its physical signs would enable the practitioner to distinguish pneumothorax from other solid or liquid formations in the thoracic cavity.

Section V.—*Pneumothorax.*

Pneumothorax, or a collection of air in the pleural sac, may be either active or passive. It is active when the air, whether exhaled from the pleura, or generated by the decomposition of a liquid effusion, by the force of its own accumulation, presses back the lung towards its

points of attachment. It is passive when the air, either entering by a communication with the external air, supplies the place of the lung diminished by its own collapse, or generated within the sac, fills up a cavity left by a re-absorbed collection of liquid, after those cases of pleurisy, in which the lung is bound down by a fibro-cartilaginous membrane, and the parietes of the chest cannot by their collapse obliterate the cavity. This division includes and defines all the varieties of pneumothorax.

The most common of all these is that variety of the passive form which results from a fistulous communication between the pleural sac and the bronchi. This communication is usually caused by the tubercular ulceration in phthisis, extending itself through the pleura. The pneumothorax, in this case, is usually accompanied by some pleuritic effusion, excited by the entrance of softened tubercle or some extraneous matter from the fistula. Active pneumothorax is of rare occurrence, and is generally like symptomatic hydrothorax, with which it is sometimes conjoined, the precursor of death. It sometimes accompanies the pleurisy excited by the bursting of a tuberculous vomica into the pleura, where there is no communication with the bronchi *.

* Louis Rech. sur la Phthisie.

The physical signs of pneumothorax are very characteristic, but they vary considerably, according to the form of the disease. In all the varieties, but particularly in the active kinds, the tympanic sound of the chest on percussion is increased, so that the diseased sounds as well as, or even better than, the healthy side; the reason is too obvious to require explanation. Hence percussion alone may be a source of error. Auscultation will correct it, and a certain diagnosis may be deduced from their conjoined indications. The sound of respiration will, by the pressure and interposition of the air in the thoracic cavity, be obliterated in all parts except at the root of the lung; whereas, in early pleuritic effusion, it may still be heard. Where, therefore, the chest is sonorous on percussion and yet no respiratory sound heard, it may safely be concluded that a pneumothorax exists. The only case in any degree approaching to this is that of emphysema, but in this the sound of respiration is only diminished, not entirely destroyed, and the presence of an occasional sibilation, and still more certainly its pathognomonic sign, dry crepitation, will clearly distinguish this disease. Add to these, that the sound of respiration, absent in other parts, remains audible at the root of the lung in pneumothorax, while no such difference is observable in em-

physema. In pneumothorax, as in pleuritic effusion, the lung is sometimes retained in contact with the chest here and there by adhesions; and at these points the respiratory murmur is not obliterated. Hence the necessity of examining every part of the thoracic surface before a correct knowledge can be attained of the physical state of the organs contained in it.

When there is a collection of both liquid and air in the pleura, the chest is of course less sonorous on percussion than in simple pneumothorax; but then the inferior parts sound very dull, while those above emit a clear sound, and the transition from one to the other is often very abrupt. On practising percussion too, in different postures, the presence of a liquid will be discovered by its rendering the sound obtuse always in the most dependent parts of the thorax; while the air, rising to the superior parts, gives them a tympanitic resonance.

It is in these cases that the presence of the liquid becomes frequently perceptible to the ear by the sound of gurgling or fluctuation, into which it is thrown by the respiratory movements, or any sudden motion applied to the thorax. Here it is, therefore, that the *succussion,* or saltatory agitation, employed by Hippocrates, furnishes a physical sign of pneumothorax with liquid effusion. The best method

of obtaining this sign is by the patient himself making a lateral jerking, or a half rotatory motion with his trunk, in the sitting posture. If he be too weak for this, the succussion may be effected by another person applying his hands to the shoulders. On applying the ear to the chest, in such a manner as not to interfere with the motion of succussion, the fluctuation of the liquid will be heard as in a cask or vessel partially filled, when it is shaken; and a reference to this analogous case will suggest to the operator the most effective method of producing the phenomenon. The roughness of this method of examination should preclude its employment in all cases of great debility, or painful irritability; for although I believe with Laennec that it is much less fatiguing than would at first be supposed, yet the excitement that it produces must, in these cases, be necessarily injurious.

There are yet other signs by which the auscultator may recognise the presence of air in the thorax. They are of singular character, and have been considered of difficult explanation; but I apprehend that the hitherto too much neglected study of acoustics will furnish us with a key to open the mystery. Every one knows that an empty room yields a kind of reverberation or prolonged echo to any sound

made in it. Need I explain that this echo is the sonorous vibration repeatedly reflected from the walls around*. The echo is in such cases chiefly in unison, or in the same note with the original sound. But substitute for the room of many cubic feet capacity, a cavity of only a few cubic inches, the sides of which are still good and uniform reflectors of sound, and then a soniferous impulse, communicated to the air within it, will be so rapidly reflected by its parietes, that the vibrations will be increased to a double, a triple, a quadruple, &c.; and the reverberation, instead of being, as in the former case, in unison with the original sound, will be in its octave, its 12th, its 15th, its 22nd, &c.†. Such an acute note rapidly dying away, strong-

* The more perfectly and uniformly reflective the walls, floor and ceiling of the room are, the more complete and durable will be the reverberation; one built entirely of stone, illustrates this in perfection. The form has little to do with the present question, except that the more uniform the surface, the less is the original sound changed; and a hollow sphere, therefore, best presents this condition. The complication of form would modify the sound; and dissimilarly reflecting composition would neutralize or destroy it. Hence a room crowded with people, with various furniture, yields little or no reverberation.

† In short in its octave, and in any of its harmonics above. This is according to a law in harmonics well known to scientific musicians.

These acute sounds are likewise produced in the reverberation of the large room, but are obscured by the louder note of unison; just so a base cord in vibration may be said to contain all the harmonics above its octave. It affords by itself a chord of real harmony; and a delicate ear can distinguish five or six of its contained notes. But the subject, syren like, seduces me.

ly resembles the tinkling sound produced by bodies of powerful molecular elasticity, such as glass, metals, &c. The elements necessary to produce such a metallic tinkling, therefore, are, 1, a cavity of uniformly reflecting parietes; and 2. the communication of a sound, or of a soniferous impulse to the air contained within it*.

Now it may be perceived that pneumothorax may combine these conditions; let us

* There are many other instances of the production of this metallic tinkling in the body, and all of them unite these conditions. It may be heard by the stethoscope applied to the stomach of a person swallowing water by teaspoonfuls. It may often be heard in the intestines, distended with gas by the sudden motion of liquid in them. An example of its production, too important to the auscultator to pass unnoticed, occurs in the meatus auditorius externus, on covering the ear with the palm, and lightly tapping on the back of the hand. Now this sound in the ear is sometimes excited by an external impulse during auscultation, particularly immediate, and might be readily referred to the chest of the patient. Laennec himself, not aware of the facts I have stated, has fallen into this error. He describes in his second vol., p. 445, a *cliquetis metallique* occasionally heard in the precordial region of persons affected with violent nervous palpitations; and considers it a sign of the presence of some bubbles of air in the pericardium. He has shown me instances of this symptom, and I have since convinced myself, by repeated observation, that it is produced solely in the meatus by the impulse communicated to the air within it. Other instances of its production, as on applying the hand to the stethoscope or naked ear and rubbing together in different ways the fingers, which Laennec refers to the presence of air in the capsules and sheaths of the tendons, may be clearly traced to the same cause by any one who will take the trouble to vary the experiments. For example, lay the ear flat upon the table, and tap the table with the finger, or something of analogous density, and the stroke will still be heard accompanied with the same metallic clink.

study what forms are most favourable to their union. The cavity is always present in pneumothorax, but it is best calculated to produce the tinkling echo when its parietes are tense and regular, as when the lung is bound down by a fibro-cartilaginous membrane. The soniferous impulse may be produced within the cavity, or may be communicated to it from without. The only cause of sound within the cavity would be a portion of liquid contained in it, dropping on change of posture, or in the motions of respiration, from the upper to the lower parts. Such a case of metallic tinkling is rare, but Laennec records an instance, and I have myself met with one. The sound is in this instance, as Laennec describes, like that of a drop falling into a decanter, a fourth full of water, followed by a prolonged ringing. The symptom in this case of course indicates the presence of liquid as well as of air in the pleura.

Sounds, external to the cavity, may cause the tinkling echo within it; and they may be communicated in several ways. Thus a fistulous communication with the bronchi may transmit a sonific impulse to the cavity on the occasion of speaking or coughing, and this is by far the most common case of tinnitus metallicus. It is here most perfectly produced

when the fistulous communication is short, but narrow, and the bronchus is of considerable size. The sound is then heard immediately after the cough or utterance, like that yielded by a wine glass when struck by a pin, and is of longer or shorter duration. Sometimes, but more rarely, the same tinkling sound accompanies respiration. If the fistulous communication be large or if there be several, the tinkling is changed into a hollow buzzing sound, like that produced by blowing into an empty bottle; wherefore Laennec calls it *amphoric resonance*. This is most distinctly heard during respiration, but likewise accompanies the cough and the voice. Amphoric resonance is obviously caused by the passage of air in and out of the pleural cavity. This passage of air deranges the reverberations that produce the tinkling echo within the cavity; hence amphoric resonance either impairs, or completely destroys the tinnitus metallicus. Let the observer bear in mind these circumstances, and he will then perceive how metallic tinkling may be succeeded by amphoric resonance, on an enlargement of the fistulous communication with the bronchi; and how the converse may result from its contraction, and that both will cease on its occlusion. To some degree the same effects may proceed in certain cases from different degrees of force in the

respiratory movements, which may of themselves open and shut the fistulous aperture. In all cases on record, this form of pneumothorax has been accompanied with more or less liquid effusion, and probably this is a necessary attendant of the pleurisy excited by the access of air or extraneous matter through a fistulous communication with the bronchi. That may therefore be anticipated, which I have had frequently occasion to observe in practice, that this liquid, by occasionally covering more or less completely the fistulous aperture, may also modify, diminish, or destroy either of the symptoms which I have been describing. Hence change of posture, by altering the situation of the liquid, may assist the auscultator to the discovery of the symptom; and in some cases might even lead him to calculate the situation of the fistulous aperture.

Laennec considered metallic tinkling a pathognomonic sign of pneumothorax with liquid effusion and fistulous communication with the bronchi. The accuracy of this opinion I am led by *theory* and *experience*, to call in question. From the theory that I have given, it may be judged that although such a lesion may be the most frequent cause of this symptom, it needs not such a complicated state to produce it. The cavity being present, as we have

said, in pneumothorax, a cause of the tinkling echo in it may be found in the transmission of a sound or sonific impulse through solid parietes. For example, the voice or cough may communicate such impulse whenever, by an induration or condensation of the pulmonary tissue, it is rendered capable of conducting to the cavity the sound from any large bronchial tubes. Such a condensation, we have seen may be produced by inflammation, and by the pressure of a liquid effusion, and might, doubtless, in some cases result from the pressure of the air of the pneumothorax itself. Add to these the case of pneumothorax, combined with such tuberculous excavation of the lung that pectoriloquous resonance is transmitted from it to the pleural cavity, but without fistulous communication:—So far in theory.

Now in the way of fact, Laennec himself furnishes two examples, which analytically prove the point at which we have arrived by theory. In one, the tinkling was produced in pneumothorax, where there was no communication with the bronchi or external air, by the dropping of a liquid in the cavity *. Another case presented the tinkling echo *after the voice*, although there was no communication with the bronchi, but only with the external air through

* The case before alluded to, Tome II, p. 348, of Laennec.

a puncture in the thoracic parietes (Tome I, p. 113.). These cases remove two of the conditions specified by Laennec, as necessary to the production of metallic tinkling; namely, communication with the external air; and transmission of the voice through a fistulous opening in the bronchi.

The following case, which fell under my observation in the ward of M. Lerminier, at La Charité, shews that the presence of liquid effusion is likewise dispensible. A boy, fifteen years of age, had been for some weeks affected with pectoral disease, with cough, shortness of breathing, scanty expectoration, &c., but these had somewhat abated, until a few days before, when they had become considerably aggravated. When I first saw him, he had besides, much fever, quick pulse, pain of side and other symptoms of an acute attack. On percussion the left side sounded well every where, but in the inferior or lateral and posterior region, where it was rather duller than usual. The right side was very sonorous on percussion anteriorly and laterally, below the fourth rib; less so above, and posteriorly. On auscultation, the respiration of the left side was distinct superiorly and anteriorly, but mixed with crepitant rhonchus laterally and posteriorly, particularly in the inferior parts. No bronchophony or bronchial

respiration. On the right side the respiration was puerile below the clavicles and in the axilla, and above the spine of the scapula; became less distinct somewhat below, and was quite inaudible below the fourth rib, the part most sonorous on percussion. In this also, after cough and utterance, a distinct metallic tinkling was heard, which appeared not to be affected by change of posture. The next day the same symptoms were present, but the crepitant rhonchus had extended upwards in the left lung; and the patient seemed worse. Tinnitus as before. Died in the course of the day. On dissection, about eighteen hours after death, about the inferior and anterior half of the right side of the chest was found filled with air, some of which escaped with a hissing noise on first incision; the lung was bound down to the whole of the posterior, and the upper portions of the lateral and anterior parietes of the thorax, by a pretty firm fibro-cartilaginous membrane, which also thickened the costal pleura of the cavity. *There was not a drop of liquid in the cavity, and there was no communication with the bronchi.* In the inferior lobes of the compressed lung were found three hydatids contained in, but not connected with, a cavity lined with a fibrous membrane. The tissue of the lung was flaccid, and compressed in their vicinity, and

bounding the cavity containing air, but above it was healthy and crepitant. The lower lobes of the left lung were found in a hepatized state, which passed superiorly into simple inflammatory engorgement; and still higher up the tissue was healthy. There were no tubercles in either lung. The rationale of the symptoms is in this case obvious. The tinkling echo was produced in the cavity by the voice, transmitted to it by the pulmonary tissue condensed by the hydatids, and perhaps also by a former liquid effusion in the pleura. This effusion had been absorbed, and the lung being bound down by a factitious membrane, a *pneumothorax of necessity* was left. Such a case of tinnitus metallicus must be very rare, as neither Laennec nor Andral have met with it: and I believe that although not in all, yet in by far the majority of cases, the organic causes of metallic tinkling are such as Laennec has defined them. The liquid effusion I cannot consider as one of the causes combining to produce it, but merely a necessary accompaniment of its cause, fistulous communication between the pleura and bronchi.

I have been longer on this article than its importance may seem to require, but the obscurity of the subject demanded it; and if I have shewn that the stethoscopic signs are less certain than they have been represented to be, this

may prevent future error, and improve our knowledge by guiding us to others more definitive.

CHAP. IV.

PHTHISIS PULMONALIS.

Section I.—*Pathology.*

The disease termed *phthisis pulmonalis,* is produced by the formation of a particular matter called *tubercle,* in the tissue of the lungs. It would perhaps be more consistent with the order of the work, if I had placed this disease among those affecting particularly the pulmonary texture; but I have been induced to prefer allotting to it this separate chapterbecaus e the previous examination of other simple diseases will better enable us to understand the pathology of this more complicated one.

I shall first trace the progress of the changes which morbid anatomy has shewn tubercles to undergo in the progress of the disease, and afterwards inquire into their nature and origin.

The lungs of those who die phthisical, present some, or all of the following changes :—

1. Small, roundish, semi-transparent bodies, of greyish or ash-coloured hue, of different shades, of a size varying from that of a millet seed to that of a hempseed, and of hardness nearly equal to that of cartilage. These little bodies are dispersed about the substance of the lung in variable numbers, here isolated, and in a tissue otherwise healthy; there agglomerated together in clusters, and surrounded by texture more or less diseased. Some are found, on close examination, and on incision, to differ from others, in having within them, generally, but not always, about their centre, an opake yellowish white spot, which, traced in different ones, may be observed to be small in some, larger in others, and in some to constitute the principal part of the little miliary body.

2. A diffused induration of the pulmonary tissue, in colour and consistence resembling the preceding, but of greater extent than they, and confined to no particular size or form. The texture of the lung can no longer be detected in the part thus affected, and, when cut into, it presents a mist, homogeneous shining surface, and is totally impermeable to air. Sometimes the induration is inconsiderable, although the other characters remain; and in rarer cases the change seems to be produced by the infiltration of a matter nearly gelatinous, slightly sangui-

nolent, which more or less obliterates the pulmonary texture. This might be considered a distinct alteration from the others, were it not that their coincidence and mutual gradations seem to identify them*. The tissue thus affected becomes, like the miliary granulations, invaded by the yellowish white spots; only these spots here appear irregular as to form and number, and extend, and gradually convert the whole into—

3. Opake masses, of a yellowish white colour, of various size, generally of a roundish form, and of consistence at first considerable, and nearly equal to that of the matter in which they were produced; but, in the course of time, they gradually become, in consistence and colour, like soft cheese, and at length attain the liquidity of pus: this change always beginning towards the centre. The miliary bodies become likewise converted into little yellow granular tubercles when isolated; but when in a cluster, frequently run together into one tubercular mass of considerable size. The yellow tubercular masses formed in the diffused induration may, of course, be of form and size as varied as those of the matrix in which they are

* This gelatinous effusion, according to Laennec, is generally observed accompanying the miliary granulations before mentioned, particularly secondary ones, produced after others have suffered the changes to be described immediately.

developed. But the yellow tubercle seems likewise sometimes to increase of itself, to extend beyond the limits of the previous induration, and to encroach on the surrounding tissue. In some few instances this progress is limited by the formation of a fibrous cyst. The yellow tubercular matter is apparently produced in some cases, without the previous induration, whether miliary or diffused; and a yellow tubercular infiltration of this kind is not unfrequently found in the lungs of children. After the softening of the tubercular matter, it is evacuated by a fistulous communication, generally into the bronchi, and rarely into the pleural sac.

4. After the softened tubercular matter is evacuated, an ulcerous cavity is left, which presents to the anatomical observer a great variety of form. The walls of the cavity are sometimes simply the pulmonary tissue, more or less red with inflammation. The result of this inflammation (excited probably by the irritation of the tubercular matter,) is, during life, on the one hand the condensation of the pulmonary texture surrounding the cavity; and, on the other, the secretion of liquids more or less purulent, and of a coagulable lymph, by which a kind of lining is formed within the cavity. The effect of this latter process is shown

in its various stages of advancement in the cavities of different ages that are met with on the examination of phthisical lungs. The coagulable lymph becomes, in time, converted into a fibro-cartilaginous membrane, the thickness and firmness of which are generally in proportion to its age.

The cavities are very various in size and form. Some would not contain more than a pea, while, occasionally, a cavity is found occupying a whole lobe. Cavities of large size are most commonly formed by the reunion of many smaller ones, produced by the evacuation of their softened tubercular contents. The ulcerative process, as it is necessary to open a communication between cavity and cavity, and between these and the bronchi, so also often extends the limits of a cavity by encroaching on the healthy tissue. In this way a lobe is sometimes reduced to a mere sac, composed of the pleura, and a thin layer of condensed pulmonary tissue. In other instances the ulcerative process has been less active, and the cavity may then be sinuous, multilocular, or composed of several small cavities communicating with each other. Occasionally, bands of condensed pulmonary tissue, crossing a cavity, are all that remain of the divisions of former small ones. Cavities recently formed, or which have only

recently communicated with the bronchi, usually, contain besides some remains of the tubercular matter in the form of a curdy liquid, pus, and a greyish or brownish grumous liquid, secreted by the inflamed parietes. Sometimes a little blood is found mixed with these, but this is seldom to a great extent, as the vessels which terminate in the cavity are almost constantly closed by coagula, and the adhesive inflammation. The quantity of liquid secreted by tubercular cavities is diminished by the formation of a fibro-cartilaginous lining, and when this is complete, the secretion is nothing more than a scanty serous, or sero-mucous liquid. Thus far of the anatomical history of phthisis pulmonalis; more particulars will be learnt from its physical signs.

It appears, then, that the principal changes of the tissue of the lung in phthisis pulmonalis are of two kinds; 1. an induration of a grey, or greyish brown colour; 2. the production, generally in this induration, sometimes elsewhere, of a yellowish white matter, at first rather hard, but becoming gradually softer, until it attains the liquidity of pus. Now, let us endeavour to discover what is the essential nature of each of these changes, what it is that causes them, and in what relation they stand to each other.

Now, in the grey induration of the pulmo-

nary tissue, whether granular or diffused, two things are remarkable; first, that there is an increase of substance, for the spongy texture of the lung is obliterated and solidified; secondly, that its substance is harder than the healthy tissue*; the first denoting the deposition of a greater number than usual of molecules by the nutritive secretion; and the second proceeding partly from the same cause, and, perhaps, partly from these molecules being unusually solid. Now the local increase in the nutritive secretion must have been preceded by locally increased vascular action; and from the degree by which the increased secretion exceeded that of simple hypertrophy of the existing parts, and amounted to an overflow and effusion in their interstices; it may be judged that this pathological increase was not less than inflammation. Inflammation we know to cause an external overflow of the nutritive secretion; and I have before† endeavoured to shew why the acute form should generally produce a soft tumefaction, and the chronic an indurated increase of substance; facts sufficiently established by Andral and others. How, then, can we view

* M. Andral has remarked that miliary granulations do not always present this indurated form, but that a careful examination may often detect small bodies of the same shape and size, but of soft consistence, and of a red colour.

† See Section on Pleurisy, p. 103.

the induration of the lung which precedes the formation of tubercular matter in any other light than in that of an effect of chronically increased vascular action; in short, of chronic inflammation? Let us, by following it in its further progress, see whether its ulterior changes destroy or increase the analogy.

We have found that, after a time more or less protracted, the indurated grey semi-transparent, but still organized mass, presents whitish points or spots, which increase in size, and at length convert the whole mass into a substance of a yellowish white colour; this generally retains at first the former consistence, but gradually losing it, becomes that soft and grumous substance, known under the name of matured tubercles. Here there is no longer organization, no longer distinction of parts; where these were, there is now but one confused amorphous magma. Now who can fail to see in this change a close resemblance to the familiar process of suppuration? familiar, but not less obscure than this. If the resemblance is so perfect in the generalities, should some slight variations in particulars, still explicable from a difference of cause, by widely separating the two phenomena, be made a pretext to multiply the objects that the mind should grasp? If the fact may be referred to a simple

and established law, shall we still leave it in the already burthened and unwieldy list of anomalous exceptions? No one is more than myself averse from hasty and excessive generalization: but still more am I an enemy to multiplying rules, when the advance of science is daily reducing knowledge into simpler forms. For this reason I would, *were the arguments equal,* incline to consider tubercles the result of a kind of inflammation, rather than with Laennec, form, on their instance, a new set of laws apart, to be applied to such bodies, under the unmeaning term of *accidental tissues**.

But I think that none of the objections usually opposed to the opinion that tubercles are produced by inflammation will apply to this view. From our inquiry we have been led to

* Much as Laennec has done in elucidating the history of phthisis pulmonalis, his opinions on tubercles and other diseased productions have always appeared to me artificial and unsatisfactory. Tubercles, according to this author an accidental tissue, are produced, or, according to some of his expressions, spring up, in a healthy tissue, without any aid of the vessels of the part; are changed from a greyish semi-transparent to an opake yellowish white, and pass from a state of cartilaginous hardness through intermediate gradations, into that of imperfect liquidity; and all this by mechanism perfectly unknown, and in a manner entirely unexplained. It is too, in my opinion, without sufficient reason, that he identified the granulations of Bayle with the yellow tubercle, bodies quite different in their physical character, only because the one is generally in time converted into the other.—As well might cartilage be called bone, or (if the example does not involve a *petitio principii*) inflamed cellular texture, a stage of pus.

consider the induration which precedes tubercle as the result of a peculiar form of inflammation, or increased vascular action, and the yellow tubercular matter which succeeds, a further effect of the same inflammation, analogous to suppuration. It has been objected by Laennec and others, who have denied the inflammatory origin of tubercles, that phthisis is by no means a common sequel of pneumonia; and I believe that the case is not sufficiently common to support the opinion that the latter is often the immediate cause of the former; but the succession does not appear too rare to exclude the supposition that acute inflammation of the lungs, by passing into a chronic form, may terminate in phthisis pulmonalis; just as we know chronic peritonitis, pleuritis, &c., sometimes date their origin in an acute attack*.

This is not, however, the principal question, although one of itself of great practical importance: the main point to be disputed, and

* The researches of my respected friend, Professor Alison, go far to prove that even acute inflammation may determine the development of tubercular matter. I have with him dissected the lungs of a child, in which matter, bearing all the physical character of tubercle, was found in parts in the acknowledged state of inflammation, whilst the healthy portions were free. Andral has recorded similar cases; and, as will appear from the opinions that I afterwards expose, I consider it as highly probable that many cases of what is called, *gallopping consumption* are instances of the development of tubercular matter, by acute inflammation in subjects of a strong phthisical diathesis.

which Laennec seems to have evaded, is whether the grey induration of the lung, which precedes the formation of tubercular matter, is not itself the result of a peculiar inflammatory state, standing in the same relation to chronic, as hepatization does to acute pneumonia. We have already, on a physiological discussion of the subject, been led to answer this question in the affirmative. Laennec, following the opposite opinion, has met with so few cases which he could consider instances of chronic peripneumony, that his view leaves it an extraordinary anomaly, that the lungs should be so rarely affected with chronic inflammation*. So far it seems reasonable and consistent with analogy, to consider the lesion in question as chronic inflammation. Pathological anatomy, which was negative in the hands of Laennec, favoured this view in the researches of Andral, by shewing the gradations which might be traced between inflammation and grey indura-

* The only kind of explanation that Laennec offers is far from being satisfactory. Speaking of chronic inflammation, he says, " il semble peu probable qu' un organe aussi vasculaire, aussi mobile, aussi essentiellement vivant que le poumon, puisse conserver longtemps l' inflammation à ce degré de lenteur et d'inactivité qui existe souvent dans les affections semblables d'organes moins necessaires à la vie." (T. 1. p. 475.) This objection, which if it had any force, ought to exclude its occurrence at all, is just as applicable on the score of vascularity to chronic inflammation in many glandular organs, and on thescore of vitality tot he destruction of the function of parts of the lung itself, by what Laennec calls accidental tissues.

tion, and the apparent transition of the one into the other. I have myself seen cases in which some portions of the lung were of a dark reddish colour, dense, but not indurated; other portions were lighter in colour, of a browner hue, and harder in consistence; other parts again, had little of the brown tinge, but were more grey from the mixture of black pulmonary matter, and in consistence likewise, closely resembled the grey induration before described; while in the vicinity, this lesion itself also occurred in an unequivocal form.

What I have here said of induration in general, will apply equally to the circumscribed form, or miliary granulations, and to the diffused induration; for they appear to differ only in respect to size. The constant form and shape that these miliary granulations present, become another matter of inquiry; and it seems probable that they are some elementary part of the lung in the state of chronic inflammation. Broussais conceives them to be the lymphatic glands; whilst Andral considers them as the individual vesicles, or single terminations of the bronchi. The latter opinion seems the most probable, and is most in accordance with my own examinations; but it requires yet further confirmation to be established.

We are then led to consider, with Andral, yel-

low tubercular matter as nothing more than a modification of pus, and a tubercle as a kind of abscess. In the formation of the yellow tubercle, the indurated tissue is removed by absorption, and tubercular matter deposited in its place*. Although the grey induration is not known to have any other termination than this in tubercular abscess, and may, therefore, be considered a stage of the disease, yet the more peculiar characters of phthisis pulmonalis depend on the formation or secretion of tubercular matter. Now, this tubercular matter, of albuminous composition, must be considered a modification of the nutritive secretion, still more destitute of vitality† than pus, and quite

* Since this was written, I have read, with much interest, the Thesis of my friend, M. Lombard, of Geneva; "Sur les Tubercules; Paris, 1827." He divides tubercles into simple and compound; and ingeniously explains the softening of the substance of the latter by ascribing it to the operation of the living portions of tissue that (as he has found) still pervade it. With Andral and myself he renounces the idea of tubercles being an accidental tissue, or identical with the grey induration; but considers them a peculiar matter secreted by cellular texture, in a state of active or passive sanguineous congestion. The view which he gives of accidental productions seems to me the most simple and philosophical that has yet been offered; and the whole work, as well as my acquaintance with the abilities of the author, give me reason to congratulate the profession that he is still engaged on this important subject, and will soon lay before the world the result of his extended labours.

† I use this word rather to avoid circumlocution, than as implying such a life in animal fluids as Hunter ascribed to them. *Capability of life* would, perhaps, more nearly express my meaning; and this seems to be generally proportionate, in the products of inflammation, to the energy of the orgasm, the overflow of vitality that generates them.

incapable of organization. Although it may, therefore, be generally considered the result of a lower degree of vascular action than that which produces pus, yet it appears to be sometimes secreted by vessels inflamed in different degrees, and even by those not inflamed at all. It is this disposition in vessels, *in different states of activity,* to tubercular secretion, that constitutes, what is called *tuberculous diathesis;* and where this prevails, the pulmonary and other tissues, apparently unaffected with inflammation, are sometimes found infiltrated with tubercular matter. Whatever be the cause which determines the secretion in these cases *, the formation of pus appears also to be sometimes in the same predicament; for I have known cases, and Andral records some, in which the presence of pus, whether in abscess, or secreted by a

* M. Andral hints that the disease may here be humoral, and depend on the formation of tubercular matter in the blood, and the idea appears plausible. I am myself disposed to consider tubercular matter, pus, and coagulable lymph, only as varieties of the same albuminous matter that exists in the blood, and differing from each other rather in mechanical condition, and consequent capability of organization, than in chemical composition. In this view, if the blood is perfect, the difference of the secretion will depend entirely on the degree of increase in the vascular action, but if the blood itself be imperfect or diseased, then whatever be the degree of inflammation, perhaps the source may be incapable of furnishing more than one or other form of secretion, and this inability may even extend to the process of reparatory nutrition. I shall, however, forbear to explain further these opinions, for they must appear too hypothetical, with any substantiatory confirmation that I could give them in this place.

membrane, had been neither preceded nor accompanied by other marks of inflammation.

I think, then, that it is of sufficient importance to distinguish three ways in which the lungs may become infested with tubercular matter.

1. By the tubercular suppuration of the indurations, whether granular or diffused, which we have been induced to consider chronic inflammations of the pulmonary tissue; this being the natural termination of such inflammation.

2. By tubercular suppurations of other inflammations of the pulmonary tissue; this effect being determined by the prevalence of the tubercular diathesis.

3. By secretion in tissue bearing no marks of other lesion, the tubercular matter being here apparently deposited through excess of tubercular diathesis.

It is these last, the most constitutional, elusive, and obscure forms of the disease, that most bid defiance to our therapeutic means; and it is, perhaps, in great measure, in proportion as these combine themselves with the other form that the disease becomes rapidly and certainly fatal. However, a predisposition to the chronic inflammations is scarcely less lethiferous, in giving spring to its irremeable course; and

what adds to the difficulty of checking it is, that it thus may run, as it were, in a double channel.

It would be an interesting, and, perhaps, practically instructive task, to trace the mode of the operation of the reputed occasional causes of pulmonary consumption, in opening one or other of these ways for the entry into the system of this demon of destruction. It is by this mode of inquiry alone, that a knowledge of a truly rational system of prophylaxis can be obtained; and so, if cure will ever be within the reach of human power, it is to be found only by the study of the pathology, and of the properties of external agents with relation to it.

The systems, or general plans in which medicine has been arranged, have been always framed on dogmas too exclusive, and observations too limited, to comprehend the varied and complicated forms of disease. Nor is it extraordinary, when the mightiness of its extent is considered, that few have been the minds that have grasped more than a very diminutive part; few the arms that have attacked, nay, the eyes that have even seen, the many heads of this formidable hydra. Hastily running to some prominent branch that comes in our way, we seize it as a prototype of the whole tree,

we clip at its twigs, and blind ourselves amongst a foliage, that we see still

"*Crescere per damnum, geminasque resumere vires;*"

whilst other branches grow untouched, supported on the trunk and root of all, beyond our reach, and even beyond our sight. Precipitately burying ourselves in the umbrageous intricacies of the foliage, we neglect the cautious and comprehensive survey that would teach us that all are centered in the trunk, that all grow from the roots.

It is no partial observer that can form for us a philosophical and comprehensive system of medicine. It is not the mechanist; for, although the body is a machine, it is much more. It is not the chemist; for although the body is a laboratory, it is much more. It is not the vitalist; for the body is not disobedient to physical laws. It is not the humoralist; for the solids have also their specific properties. It is not the solidist; for the fluids may change of themselves, or be changed from without. It is not the empyric; for neither bodies, nor even the body, are always the same. Nor is it the morbid anatomist; for his dissections teach him little of causes, or of their relations with effects. It is to him who is all, and none of these; who views the animal body as a machine of its own kind, obeying physical and chemical laws in

unexampled complication, and further disguised by a combination with others peculiar to living structure; and who, duly regarding all these powers, seeks, in a change in their relations, the causes and the cures of disease; it is to THE PHYSIOLOGICAL PATHOLOGIST that I would look for the improvement of medicine; and to the combined exertions of many such, for the ultimate achievement of its greatest possible perfection.

SECTION II.—*Physical Signs.*

In the early stage of phthisis, when the rational symptoms are seldom more than those of catarrh, or other pulmonary affections, such as cough, occasional pain of chest, slight dyspnœa, or, rather, tendency to anhelation on exertion, &c., the presence of tubercles, or of the indurations that precede them, will produce physical signs more or less appreciable, according to the situation and extent of the diseased parts. Thus the miliary indurations, even in considerable number, may be scattered through the tissue of the lung, without producing any distinct diminution or change in the resonance of the chest, or the sound of respiration. But if, (and it is the most common case,) the induration or tubercular degeneration be partial, or

affect one part much more than others, then the sounds of respiration and percussion will be distinctly modified, and particular signs will be produced in the diseased parts. What these signs are, will appear from the physical change in the organ.

Where the texture is solidified by the disease, there the elastic resonance on percussion must be diminished, and the sound of vesicular respiration more or less obliterated; whilst those of bronchial respiration, and vocal resonance, are transmitted in an increased degree. Now, in by far the majority of cases, the principal accummulation of granular indurations, and of tubercular formation, takes place at the apex of the lung, which is immediately under the clavicle, and a small space below it. If, therefore, this bone, when struck about its middle, yields a dull sound, or duller on one side than on the other, it is exceedingly probable that the lung is in that part affected with phthisical degeneration. Great care must be taken to strike both clavicles at the same point, for the natural resonance is always less according to the distance of the point struck from the sternum. It is therefore generally expedient, to avoid error, to have the parts uncovered, and to tap the two clavicles alternately at corresponding points, with the middle finger, or the knuckle of the fore-

finger*. When the disease is extensive, this dulness of percussionary resonance extends to the infraclavian region. There is sometimes such an accumulation of tubercles also about the root of the lung as to cause a dull sound on percussion between the scapulæ.

The stethoscopic signs are more delicate, but, perhaps, more equivocal tests than those of percussion. When the tubercular induration exists in a degree even less than that required to change the percussionary resonance, the respiratory murmur will be less distinct than usual; or it may present somewhat of a hissing or bronchial character; and a diffused bronchophony, or unnatural fremitus on the exercise of the voice will be heard in the corresponding points of the chest. It is when they are more manifest on one side than on the other, that

* The indications of percussion are sometimes deceptive, from the combination of a partial emphysema with the tubercular or miliary induration. This dilated state of the air-cells in the vicinity of indurated vesicles and bronchi, which is explained in the view which I have given of the pathological causes of emphysema, may counterbalance all effect produced by the indurations. This circumstance, which was first pointed out to me by my friend, Dr. Edwin Harrison, must increase the number of causes, in which even the physical signs are negative. But by this emphysema, the respiratory sound in the part will be diminished to a degree inconsistent with the healthy resonance on percussion. And from the proofs which Dr. Harrison has given me of the perfectibility of percussion, as a test of the density of parts, I do not despair of finding, by its means, a distinction between minuter gradations of difference than have hitherto been discovered.

these signs are the most certain, and existing in points where the respiratory murmur is naturally quite vesicular and free from bronchophony; as in that part of the subclavian region which is close to the head of the humerus. Towards the sternum, in the interscapular region, and in the axilla, these signs indicate the probable existence of tubercles, *only when there is a distinct difference between the two sides of the chest;* for the distribution of the bronchi in these parts is often such as naturally to produce similar phenomena.

Such are the direct signs of tubercles and the granular indurations; but usually there coexists some inflammation of the bronchial mucous membrane, which adds to, and, perhaps, somewhat obscures these signs, by producing different catarrhal rhonchi; generally the sibilant and the sub-mucous. It is to this concomitant bronchitis that we must ascribe the expectoration of the early stage of consumption. It is usually scanty, the cough being dry; but sometimes it is pretty abundant, and consisting of pituita, a thin glary liquid, which generally indicates numerous miliary granulations. Hæmoptoë is a frequent, but not constant precursor of phthisis, and it seems, in some cases, to be caused by the presence of miliary indurations and tubercles obstructing

the circulation in the lung, and exciting a violent straining cough; and in others, in the form of pulmonary apoplexy, to precede, and probably occasion, the development of the tubercles themselves.

I think, on the whole, that in the greater number of instances, the physical signs of this stage of tubercles are such as to give strong, but not conclusive, evidence, of an incipient phthisis; and cases, that are perfectly free from them may, accordingly, be regarded so much the more favorably. The practitioner should, however, be very guarded in pronouncing on the nature of the disease at this period: he should wait for the results of repeated examinations; when, if tubercles are really present, their signs will generally become more evident daily, and at last of a nature quite unequivocal.

It is when the tubercles, having passed into the softened state, become evacuated through the bronchi, and leave a cavity communicating with them, that the most characteristic signs of phthisis manifest themselves. In the cavity thus formed, the sound of the air passing in and out through the liquid that it still contains, is the first sign, and constitutes what is called *gargouillement, the gurgling* or *cavernous rhonchus.* It may be considered as an exaggeration of the mucous rhonchus, and it so nearly resembles

that produced in the trachea and large bronchial ramifications, that the symptom must be considered doubtful, when heard only near the sternum, in the axilla, or in the upper part of the interscapular region; as it may here be produced in these air-vessels. The rhonchus cavernosus will vary a good deal, according to the form and size of the cavity, and the quantity and spissitude of its liquid contents. This variety may be easily conceived without description, on a consideration of the physical nature of the phenomenon. When this cavernous rhonchus is heard over a considerable space, there are probably several cavities communicating with each other, and all containing a considerable quantity of liquid. When the subject is thin, and the cavity superficial, percussion in its vicinity sometimes produces a sound something like that of a cracked cup or jar, struck with the knuckle. This is only a modification of the gurgling, rendered somewhat metallic by the tinkling echo of the neighbouring bronchial tubes*.

As the liquid contents of a cavity are evacuated by expectoration, the cavernous rhonchus passes into what is called the *cavernous respira-*

* This sound may frequently be produced in the dead body by percussion under the clavicles; but it does not here always indicate a cavity, as its seat is usually in the trachea and larger bronchi.

tion. The sound of this is very characteristic, and represents to the mind exactly the passage of air in a cavity. It has not the diffused, slightly crepitant sound of vesicular respiration, is more sonorous and circumscribed than tracheal, and in different examples may be very perfectly imitated by blowing into shells of different sizes. As cavernous respiration differs according to the size of the cavity in which it is produced, so the variety of sound may be taken as a means of judging of its size; the rule generally being that the deeper and hollower the sound of cavernous respiration, the larger is the cavity.

There are, however, other sources of variety which it is important to notice. Thus the sound may be like the blowing of a bellows, or contracted almost to a whistle, according as the communication with the bronchi is free or constricted. If, with a contracted bronchial orifice, the cavity be of a large size, particularly if lined with a rigid false membrane, the respiration will become *amphoric,* or like the sound produced on blowing into a phial; partaking of the character and explanation of that before described as occurring in pneumothorax.

The thickness of the parietes of the cavity do not, so much as might be expected, modify the sound of cavernous respiration. It may

sometimes be heard distinctly through healthy tissue more than half an inch in thickness, and seems then more distant. When the cavity is more immediately contiguous to the parietes of the chest, the sound appears so near, that the auditory impression is like that of blowing into the ear itself. Sometimes it comes only in successive puffs, apparently interrupted by something moveable suddenly interposed; and this, according to Laennec, occurs when a very thin stratum of pulmonary tissue, still spongy, forms the parietes of the cavity immediately opposed, but not adhering, to the pleura costalis.

The cough, which may be considered an exaggeration of respiration, gives the same varieties of character as this latter, and sometimes may produce the signs, when ordinary respiration does not effect the entrance of air into the cavern. When the cavern has only recently communicated with the bronchi, or when it is again nearly filled with sputa, the air enters it and produces the cavernous rhonchus, only in the fuller inspiration that accompanies cough. In other cases this respiratory movement often renders the signs of the existence of a cavern, more certain and unequivocal. In a cavern that is vast in size, and pretty simple in form, and having only a narrow orifice communicating with the bronchi, the respiration may be

insufficient to have such free access to it as would give the sign of amphoric resonance; but the cough would not fail to make its existence known, by the tinkling echo, (tinnitus metallicus,) that, as in pneumothorax, would accompany it.

Another most distinct and certain sign of a cavity in the lungs is furnished by the voice. We shall best understand this by referring to what we have formerly said on the production of the voice. Now that reverberation which exists in the trachea and bronchial tubes of larger size, we then observed, is so broken down and destroyed in the finer complication of the cellular parenchyma, that either the voice is not propagated at all through it, or only a dull diffuse fremitus is heard. But if a cavity be formed in this parenchyma, and a prolongation of the bronchial *sounding board* thus produced, the voice will then be heard in the corresponding part of the chest, in a tone and intensity more or less perfect, according as the cavity is adapted to receive and transmit the vocal resonance from the bronchi.

When the cavity is of moderate size and regular form, and in free communication with a large bronchial tube, and either it is very near the surface of the lung in contact with the thoracic parietes, or the intervening tissue is rendered a good

conductor by condensation, the voice is transmitted in the most perfect and unmodified manner, and seems to be produced in that spot of the chest, seemingly distinct from the oral voice. This is perfect pectoriloquy. If heard with the stethoscope, (which for this purpose is best adapted with the stopper in,) the sound of the voice seems to come through the tube, and enters the observer's ear louder than that which, coming from the patient's mouth, strikes the other ear; but the verbal utterance is never so distinct*. When heard, to the degree just described, in parts where there is little or no resonance of the voice, it proves (equally with cavernous respiration) beyond doubt the existence of a cavern communicating with the bronchi.

It is less certain when occurring near the sternum, in the axillæ, and between the scapulæ; but if the resonance seems defined, passes up the tube, and is heard to this degree on one side only, there can be little doubt even in these cases: for the natural bronchial resonance of these parts scarcely ever passes the tube, is

* How often does the voice thus heard make known a melancholy truth, the speaker never dreamed of. More than once has it occurred to me that the very words, which, in that delusive confidence with which this malady enshrouds its victims, ridiculed my examination of the chest, roundly saying, that nothing ailed them there, have belied their meaning, and coming from the breast, have told a far different tale!

generally diffused, or can be traced in a line along the course of the bronchus, and is rarely very unequal on the two sides. That part of the acromian region in the angle formed by the junction of the clavicle and coracoid process of the scapula, may admit of examination; for if the stethoscope is held nearly perpendicularly on this spot, it is out of reach of the laryngophony heard in other parts of this region. It may be held in mind that natural bronchophony exists most in young or thin subjects with a sharp voice, and is generally slight in those who are stout made, and have deep voices: but the same circumstances are also favourable to the distinct development of pectoriloquy.

Imperfect pectoriloquy is that kind which does not seem to enter the stethoscope, but only to resound at the end. This standard of imperfection will not, however, always denote the uncertainty of the indication; for what is, according to this definition, imperfect pectoriloquy, if it occur where it cannot be confounded with natural resonance, particularly if confined to one side, may be deemed a pretty certain indication of the existence of a cavity. It cannot be trusted to when heard in the internal half of the infraclavian and mammary regions, the axillæ and interscapular spaces. Neither is it always possi-

ble to make this distinction in pectoriloquy, although in the extreme degrees it is sufficiently apparent; for sometimes it seems only partially to enter the tube, some words being loud and near, and others in the same sentence more distant: a very bass voice scarcely ever seems to traverse the tube completely.

The smallness of the size of a cavity, its imperfect communication with the bronchi, or its distance from the surface may render pectoriloquy of the imperfect or doubtful kind; hence these conditions being changed, (as often happens in the course of the disease) the pectoriloquy will again become perfect, and *vice versâ*. So likewise doubtful signs of a cavity may be taken as certain, if they arise suddenly in a spot where such had never before been observed; particularly if this happen after coughing and expectoration.

The vocal resonance is sometimes modified in pectoriloquy. This not unfrequently happens when there is a little liquid in the cavity, which being occasionally raised in bubbles, interrupts the sound and gives it somewhat of a saltatory and slightly tinkling character. The vocal resonance is also sometimes alternated with puffs of cavernous respiration; for it may happen, if the communication with the bronchi is small, that a little increased force in the

passage of the air though the cavern, may momentarily prevent the transmission of the vocal vibrations into it. Cavities of irregular form, with partial septa and soft loose parietes, do not produce so perfect a pectoriloquy as those of simple form and smoothly lined. Those of moderate size perhaps are the best adapted to produce the symptom; but Laennec relates an example where a cavity not larger than a plum stone produced a distinct pectoriloquy. When the cavity is very large, the communication with the bronchi is often not sufficient to transmit the full vibrations of the voice to the large volume of air in the cavity: In that case, a tinkling echo accompanies the voice, as in pneumothorax; and this will be more metallic and resounding, in proportion as the cavity is ample, and its parietes smooth and tense. Percussion, as well as the history of the case, will generally suffice to distinguish this case from pneumothorax: The sound is never so clear, and when mediate percussion is used, it may often detect irregularities from the varied density of the subjacent parts, which do not appear in the elastic drum-like sound of pneumothorax.

The pectoriloquy, produced in a string or row of small excavations, frequently presents much of the character of bronchophony; the tone of the voice being rendered more sharp, and

somewhat cracked. It may be sometimes difficult to distinguish between this, and bronchophony produced by a partial inflammation: the history may generally determine whether an ordinary pneumonia has taken place; but if an inflammation of the intercurrent kind, has been engrafted on a chronic catarrh, or other affection of the lungs, the symptoms of the latter may have masked its progress, and it may thus have escaped observation. However, in this case there is generally some indication, either in the expectoration, the remains or return of the crepitant rhonchus, or the cessation of the bronchophony, that will be sufficient to distinguish the inflammation. An intercurrent circumscribed inflammation frequently occurs in lungs affected with tubercles in different stages; and in a greater extent is not uncommonly the immediate cause of death. The checking of such inflammations at their commencement is a principal object in the treatment of phthisis; for, besides the immediately fatal effect that they sometimes determine, they certainly tend to accelerate the progress of the tubercular disease. Hence the expediency of frequently using the stethoscope in phthisical cases, to insure the detection of the inflammation at a time when a few leeches or a counter-irritant may be sufficient to check it, without wasting

by depletions the little pittance of strength that might still hold on existence a short period longer. I formerly mentioned, when speaking of chronic catarrh, that the signs of an extensive dilatation of the bronchi resemble those of a tubercular cavity in phthisis. Where a bronchus is dilated at a point to the size of a hazel nut, or even of a plum stone, it is plain that it is physically capable of producing all the signs of a tubercular cavity of the same size; that is, a coarse gurgling rhonchus, if it contain liquid; and cavernous respiration and pectoriloquy, if it be empty. The case of such a dilatation is not common, but it does occur; and as the other symptoms resemble those of phthisis, it may be mistaken for this disease. In time, however, a distinction may be made by the signs of progress which the tubercular disease generally presents; the cavity becomes more extended, and causes signs of *hollow*, more remarkable and extensive than dilated bronchi could produce; and not unfrequently cavities are formed in other places. Dilated bronchi rarely affect the sonoriety of the chest on percussion, to the degree that the engorgement and infiltration about the tubercular cavities do; nor can they produce the other physical signs of large cavities. The most common situations of dilated bronchi are, in the sca-

pular, mammary, and lateral regions: the subclavian and acromian are the more usual seats of phthisical signs.

There is generally some condensation of tissue in the neighbourhood of tubercular cavities; owing either to other tubercles in a crude state, or to the effect of chronic inflammation. Hence it seldom happens that the chest recovers its natural resonance on percussion on the corresponding points, even after the contents of a cavity have been evacuated. When the cavity is large and superficial, the chest may sound well in some places over it, but its resonance is irregular, and less elastic, and if the other side is still in a healthy state, a remarkable but indescribable difference may be both heard and felt by the percussor.

I have mentioned that fistulous cavities have a tendency to increase in size; and this may be effected either by the softening and evacuation of neighbouring tubercles, or by simple ulceration of the adjoining tissue. Thus the symptoms will, by the extension of the disease, become more and more evident, in too many cases, and soon put the diagnosis beyond a vainly-hoping doubt.

If the cavity be near the surface of the lung, and there be no adhesion of the pleura at the spot, there is a chance of a perforation of the

pleura taking place, and producing a pneumothorax. This accident is commonly manifested by the sudden occurrence of the general signs of acute pleurisy, caused by the irritating effect of the tubercular matter and air upon the pleura. I have already described pneumothorax produced in this manner; and refer to what I have there said for an account of the physical signs. They are often very remarkable. I have heard, in a case of this kind, an amphoric respiration, so loud that it could be distinctly perceived without applying the ear or the stethoscope to the chest, and, I think, must have attracted my observation, if I had known nothing of auscultation.

The evacuation of a softened tubercle into the pleura, without communication with the bronchi, is of more rare occurrence. It generally produces a pleurisy, which is remarkable for the suddenness of its attack. The effusion is sometimes accompanied with a disengagement of gas in the pleura. If the phthisical disease is not far advanced, the effusion may be absorbed, and adhesion formed between the pleura; but the shock of acute attack is often too great for the wasted tottering frame to bear, and the patient falls under it.

The expectoration, in the latter stage of phthisis, consists of softened tubercles, and the

secretion of the tubercular cavities, together with a secretion from the bronchi, more or less copious as the concomitant catarrh is severe. The expectoration of tubercular matter, when it can be clearly proved, may be considered a decisive evidence of the existence of phthisis; but it does not often present itself in the sputa in this unequivocal form; and it is often a matter of much difficulty to distinguish between it and certain secretions of the diseased bronchi, as well as of the tonsils. Sometimes little portions of the pulmonary tissue are brought up with the curdy and purulent matter of cavities, and then the case ceases to be doubtful. The pus and muco-purulent matter, sometimes tinged with blood, proceed more from the inflamed bronchi than from the cavities themselves. A grumous liquid, of a grey or brownish colour, is occasionally seen in the sputa; and this seems to proceed from the inflamed parietes of the cavities; and when they become lined with a fibro-cartilaginous membrane, this liquid becomes more serous.

The formation of this membrane is the effort of nature towards the cure of phthisis; and the researches of Laennec have given satisfactory proofs that this effort is not always unsuccessful. The process is simple. The vessels of the cavity throw out a lymph; this becomes con-

verted into a fibro-cartilaginous membrane, which gradually increases in thickness until it fills the cavity. The mass of fibro-cartilage thus formed, in time becomes smaller and more dense, drawing in the pulmonary tissue, and at length forms little more than a kind of cicatrix, around which the puckerings of the texture are very remarkable. The signs of such change are the diminution and gradual cessation of the symptoms of a cavity; and if the cavity was large, its cicatrization will produce some contraction of the chest on that side.

Many, very many, are the causes that prevent the success of this process of nature. Too often, if the lungs are not already too extensively pervaded by tubercles to leave enough pulmonary tissue after their evacuation and the cicatrization of the cavities, to support life, the constitutional cause engenders more; so that, while some cavities are healing, other tubercles are generated, which may be fatal either by their present abridgement of the pulmonary function, or, by the exhaustion produced by the ulcers entailed by their suppuration. Add the number of contingent causes that may prove fatal before this curative effort can take effect; hæmoptysis, inflammation, suffocation by sudden bursting of a vomica, perforation of the pleura, bodily exhaustion, constitutional

complication—all, and many others coming in the deadly train—and we shall see how diminutive is the chance of recovery from phthisis.

The case that should afford us hope is that in which the pulmonary organic disease seems to be limited, the function little embarrassed, the body not much reduced, and neither harassed by a complication of complaints, nor tainted by hereditary diathesis. Even others of worse aspect *may* turn out favourably; experience has proved it; and although in them our anticipations cannot be brightened by hope, neither may they be totally darkened by despair. And thus, if the study of physical signs shall often appal us by discovering the dreadful enemy that holds an object of our care, it has also established the consolatory fact, that its grasp is not universally relentless.

There is little need that I should detain the reader by any notice of some organic diseases of the lungs, of rare occurrence and obscure nature; for whatever is known of them will suggest to him, now accustomed to the acoustics of the chest, the physical signs that are likely to accompany them. Thus *melanosis*, as it runs a course somewhat analogous to that of tubercles, so it will partake of their physical signs*. In their solid state, melanose tu-

* Melanose matter seems to differ from that of tubercles, principally in being composed of a modification of the colouring matter of the blood,

bercles may produce dulness on percussion and bronchophony; and after softening and evacuation, the usual signs of a cavern. The presence of the melanosed matter in the sputa can alone distinguish the case from one of ordinary tubercular phthisis.

The same rule may be applied to *cretaceous formations, scirrhous* and *osseous degenerations,* according to the physical state which they hold in the lung.

Hydatids in the tissue of the lung may likewise produce bronchophony, and, when evacuated, leave a cavity, with its usual signs. The possibility of distinguishing any sounds produced by the motions of the animals themselves, we must consider at least as very apocryphal.

as an altered albumen constitutes the latter. The change of the colouring matter is, in some instances, very great, and proceeds partly from the presence of a black insoluble matter. Whether this resembles in nature the carbonaceous matter commonly found in the lungs, or is allied to the black colouring matter, *pigmentum nigrum*, abundant in the negro, and scantily produced in parts of the white, has not been clearly determined. Let me remark of the black pulmonary matter, that whether it be derived, as seems probable, from the sooty particles that constantly float in the air where combustion is going on, as suggested formerly by Dr. Pearson, or be it the product of the body itself, it is not extraordinary that the lungs should be its peculiar seat: for it is perfectly insoluble in any animal fluid; and if at all arrested in the circulation, it must be in the fine vascular filtre of the lungs, where it will remain, and accumulate. Like the carbonaceous matter of tattooed skins, and the insoluble oxide of silver in those who become coloured by the internal use of lunar caustic, it remains, not because there are no textural absorption and reparation, (an opinion which, with his sagacity, I am surprised that Majendie should have maintained,) but because that absorption can act only on matter in a state of solution.

EXPLANATION OF THE PLATES.

PLATE I.—*Construction of the Stethoscope.*

I HAVE already exposed the general principles of the construction of the stethoscope; this plate will enable us to come to particulars. We have said that the office of this instrument is triple: 1, As a solid conductor, to convey sounds along its fibres; 2, As a tube to contain a column of air, through which sounds are conducted; 3, As a perforated cylinder hollowed at one end, to concentrate, in the central canal, sounds produced over some extent of surface. Now the perfection of a stethoscope will depend on its being so constructed as to fulfil best all three parts of its office.

First, as a solid conductor. The wood of which it is composed should be of straight and rigid longitudinal fibres, uninterrupted by knots or inequalities. The ends of these instruments should be so formed as to bring the ends of these fibres in close contact with the parietes of the chest, from which the sounds come, and with the ear, to which they are transmitted.

The central canal, which prepares the instrument for the second part of its office, does not materially impair it as a solid conductor. This canal should be perfectly straight, with walls as even and smooth as they can be made, so as to offer no obstacle to the parallel vibrations, and to reflect onwards the oblique ones. It is of essential importance in using the instrument, that it be so applied to the chest and ear, that this central canal shall have no communication with the external air, otherwise the vibrations would be lost outwardly, instead of entering the auditory meatus. The

end applied to the chest should, therefore, be made slightly concave, the better to secure its exact and perpendicular apposition to it. The form of the other end must be adapted to the ear of the auscultator. If his ear be flat, it may be made flat or very slightly concave; but if the tragus and antitragus are prominent, it must be made concave in a proportionate degree, otherwise they may be pushed in, and close the meatus. The end fits better to most ears, by being enlarged a few lines in diameter by a horn or ivory ferule, or ring, glued round it; or a perforated cap of ivory or horn, as A in fig. 4, may be made to fit closely on the end CC.; and that this may impede the transmission of sound from the wood as little as possible, it must be made very thin, and lined on the inside with soft leather, and fitting so close as to leave no interstices. I should feel no hesitation in preferring the ring D, fig. 3, if it were not that this cap may be made otherwise useful as a percussion plate, in the manner described at p. 22. This, and the circumstance that the cap may be removed in auscultating the sound of the heart, &c. where the solid fibres are the best conducting media, may therefore give the cap the advantage; but both of its uses render it absolutely necessary that the perforated lamina covering the end should be very thin. The cap or ring impedes, rather than assists, the adaptation of the instrument to the ears of those whose temporal zygoma is very prominent; and, in other cases, the breadth and concavity of the ear end of the stethoscope must be proportioned to the size and form of the ear of each auscultator. He should not be hasty in choosing his instrument, but when he has found one exactly to fit his ear, he will obtain a more perfect tact by confining himself to it, than by using a variety.

We have lastly to consider the excavation, which enables the instrument to concentrate diffused sounds; and, to illustrate the superior advantage of the conically shaped excava-

tion, I have given, in figs. 3 and 4, sectional diagrams, representing the manner in which the direct vibrations are reflected. In the parabolic cavity, fig. 4, they are reflected back on the surface from which they proceeded, and cannot reach the central canal, but by repeated reflections, which must tend to impair their distinctness and intensity, inasmuch as no surface is a perfect reflector. The sides of a conical cavity, fig. 3, subtending an angle of about 25°, reflect all the direct vibrations, which are the most important ones, immediately into the central canal, so that they reach the ear little impaired by reflection. If the angle be greater, it will partake more of the objectionable property of the parabolic curve, as may be judged by a reference to the figures.

The perforated stopper or plug, E F. fig. 1, by fitting exactly into the cavity G, reconverts the instrument into the perforated cylinder. It ought to fill the cavity completely, and to hold tightly in it by the flute joint H H, and I I. To render the instrument more portable, and to facilitate its application to some parts of the chest, it is made to divide in the middle at K K, with a conical joint, so exactly corresponding with that at the end of the instrument, that the plug E F will equally well fit the cavity K K L. The excavated ends are strengthened by small ivory or horn ferules, K K, without which they would be apt to split. The wood should be well dried before these ferules are glued on, otherwise they are liable to become loose. The whole internal surface of the instrument should be as even and smooth as possible, in order to perfect its reflective powers. Fig. 1, represents a longitudinal section of the instrument in all its proportions, one half the real size.

Such I believe to be the best construction to fit the stethoscope for its several purposes. Others may consider portability or elegance of greater importance than such minute attention to acoustics as I have held necessary.

Fashion and fancy have, accordingly, been at work in devising stethoscopes of various forms, more or less paradoxical. The medical amateur may meet with them in the shops, and may amuse himself in trying to find out the principles of the peculiarity of their construction.

FIG. 1.—LONGITUDINAL SECTION.

AA. Stethoscope.
BBB. Its central canal.
C. Its ear end.
D. Horn or ivory ring.
EF. Its stopper.
G. Excavated end.
HH. Flute joint, corresponding with I I.
KK, KK. Horn or ivory ferules.
LLL. Middle division.

FIG. 2.

A horn or ivory ear piece, or cap, fitting on the end of the stethoscope, CC. BB. inner surface, covered with soft leather, and made convex, exactly to correspond with the concavity, DD.

TABULAR VIEW

OF THE

THORACIC REGIONS, THEIR NATURAL RESONANCE ON PERCUSSION, &c.

TABLE I.

Regions. Plate II.	Number.	Situation.	Natural Sound on Percussion.	Interior Corresponding Parts.	Signs commonly produced thereby disease.
1. Clavicular (subclavian of Laennec).	2	Clavicles.	Very clear towards the sternum; clear in the middle; dull close to the humerus.	Apices of the lungs.	Dulness on percussion in phthisis; generally most on one side.
2. Infraclavian (anterior superior of Laennec).	2	Between the clavicles and the 4th ribs.	Very clear.	Superior lobes of the lungs; large bronchi near the sternum.	Irregular dulness on percussion, diffuse bronchophony, impaired respiration, and afterwards cavernous rhonchus and pectoriloquy, in phthisis. Various rhonchi in catarrhs.
3. Mammary.	2	Between the 4th and 8th ribs.	Very clear; particularly by mediate percussion. In women a clear sound can be obtained through the mammæ only by mediate percussion.	Middle lobes of the lungs; large bronchi in the upper part, near the sternum; the heart, generally covered by the lungs, in the lower part of the left region.	Rhonchi in catarrh; more rarely phthisical symptoms. On the left side, dulness on percussion in pericarditis and enlargement of the heart; increased impulse in hypertrophy, and increased sound of pulsation in dilatation of the heart; sometimes extending to the right, with or without *murmur follis* or *limæ*.
4. Infra-mammary.	2	Between the 8th ribs and the margin of the cartilages of the false ribs.	Dull on the right side: on the left irregularly dull, or unnaturally resonant.	The liver on the right, and the stomach on the left side, covered only on the upper part by the thin margin of the anterior inferior lobes of the lungs.	Crepitant rhonchus in incipient pneumonia. Extinction of respiration in advancing pleurisy. Dry crepitation in interlobular emphysema.
5. Superior sternal.	1	Upper part of the sternum.	Very clear.	Large bronchi.	Bronchial rhonchi in catarrh.
6. Middle sternal.	1	Middle part of the sternum.	Very clear.	Margins of the middle lobes of the lungs.	Catarrhal rhonchi.
7. Inferior sternal.	1	Lower part of the sternum and ensiform cartilage.	In the upper part clear; rather less so in fat persons. Below, sometimes more dull; sometimes tympanitic.	Above, margins of the lungs; below, the heart, liver, and sometimes the stomach.	Signs of diseases of the right side of the heart: dulness on percussion in pericarditis, accumulation of fat, hypertrophy, &c.

Regions. Plate II.	Number.	Situation.	Natural Sound on Percussion.	Interior Corresponding Parts.	Signs commonly produced there by disease.
8. Axillary.	2	In the axillæ above the 4th ribs.	Very clear.	Upper part of the lateral lobes of the lungs.	Dulness on percussion, cavernous rhonchus, pectoriloquy, &c. in phthisis. Catarrhal rhonchi.
9. Lateral.	2	Between the 4th and 8th ribs at the sides.	Very clear.	Middle of the lateral lobes of the lungs.	Dulness on percussion in advanced plcurisy : and on the right side, from enlarged liver. Ægophony in advancing pleurisy: crepitant rhonchus, and bronchophony in advancing pneumonia.
10. Inferior lateral.	2	Below the 8th ribs, at the sides.	The same as the infra-mammary.	Margin of the lateral lobes of the lungs ; the liver on the right side ; the stomach and spleen on the left.	Crepitant rhonchus in incipient pneumonia. Extinction of respiration in pleurisy.
11. Acromial.	2	Between the clavicles and upper margin of the scapulæ.	Dull by direct percussion. A tolerably clear sound may be elicited by mediate percussion, particularly near the clavicles.	Superior lobes of the lung, and large bronchi.	Dulness on percussion in extensive tubercular accumulation ; cavernous rhonchus and respiration, and pectoriloquy in phthisis. Catarrhal rhonchi.
12. Scapular.	2	The scapulæ, and the muscular ridge below them.	The pectoral resonance can be elicited from this region only by mediate percussion.	Middle posterior lobes of the lungs.	Catarrhal signs. Ægophony in pleurisy. Bronchophony in pneumonia.
13. Interscapular.	2	Between the inner margin of the scapulæ.	Pretty clear by mediate percussion, or when the arms are crossed, and the head bowed forwards. The spinous processes of the vertebræ sound well.	The roots, and inner parts of the posterior lobes of the lungs.	Catarrhal signs. In the upper portion the sound of respiration is never destroyed in effusions into the pleura. The lower portion is sometimes the seat of ægophony in pleurisy, and of rhonchus crepitans, and bronchophony in advancing pneumonia.
14. Inferior dorsal.	2	From the inferior angle of the scapulæ and border of the serrati, below them to the level of the 12th vertebra.	Clear in the upper portion, by striking on the angles of the ribs, or by mediate percussion. Below, often dull on the right, and unnaturally resonant on the left side.	Base of the lungs. The liver encroaches on the right, and the stomach on the left side.	Crepitant rhonchus and bronchophony in incipient pneumonia and œdema ; ægophony in pleurisy, and dulness on percussion in both.

TABLE I.—Plate II.

In this tabular view of the regions, I have added a general summary of the symptoms of which they severally are the most common seats; and I have done this more with a view to assist the memory in a general way, than as giving any exact description. Assisted by Plate II, it gives a ready view of the situations of the regions and the organs within the chest, and a summary of the signs produced by disease.

Since my first sheets were printed, the work just published by M. Piorry, "*De la Percussion Mediate,*" has been put into my hands by my friend Dr. Clark, to whom I am likewise indebted for many valuable hints on the arrangement of this work. The perusal of M. Piorry's book, as well as some communications from my friend Dr. Edwin Harrison, who has with much success applied his acute mind to the study of percussion, have convinced me of advantages in *mediate percussion,* greater than, from my then experience, I had expressed at the beginning of this work. By percussion on the pleximeter, closely applied to the part, the pulmonary resonance can be elicited from parts which yield no sound by direct percussion. Thus, in the scapular and acromial regions may a sound be obtained, which, although not equal to that given by other parts with thinner parietes, is obviously hollow, and proceeds from the deep-seated aereal contents, and would, undoubtedly, be rendered obtuse by a substitution of solid or liquid in the interior. I must remark, however, that signs thus obtained must not be trusted equally with those of other parts; for, besides that the difference is less marked, the sound

may proceed, where the parietes are so thick, not only from the part under the point struck, but from those in its neighbourhood likewise.

Moreover, M. Piorry asserts that mediate percussion may distinguish differences in density, of a deep-seated, from that of a superficial organ. Thus, by holding the pleximeter lightly, and tapping gently on it, a very slight pleuritic effusion may be detected by the dulness of the sound; and by using some pressure and force in percussion, the resonance of the spongy lung beyond can be elicited, and in this manner much slighter gradations of the disease may be discovered than can be detected by immediate percussion. This test is equally delicate in distinguishing the confines of the lungs, the situation and extent of the heart, &c., much more exactly than can be done by the method of Avenbrugger; and it certainly is an important addition to the physical method of diagnosis.

TABULAR VIEW

OF THE

CHARACTERISTIC PHYSICAL SIGNS OF DISEASES OF THE LUNGS AND PLEURA.

TABLE II.

Disease.	Physical Signs in the Part Affected.			Sputa.
	Pectoral sound on percussion.	Respiratory Sounds.	Vocal resonance.	
Acute Bronchitis.	Sometimes slightly diminished.	Weak in parts; accompanied by a rhonchus, first sonorous or sibilant, afterwards mucous. Towards the end, respiration sometimes inaudible in some spots.	Natural.	Mucous, at first thin, afterwards viscid.
Chronic Bronchitis.	Slightly impaired, if the catarrh is extensive.	Weak in parts, or irregular, with mucous rhonchus.	Natural. Bronchophony, or even pectoriloquy in dilated bronchi.	Mucous; sometimes purulent, sometimes streaked with blood.
Pituitous Catarrh.	Partially impaired.	Weak, with sonorous, sibilant, and mucous rhonchi.	Natural.	Pituitous.
Dry Catarrh.	Natural.	More or less extinct in parts. Occasional sibilant, sonorous, and dry mucous rhonchi.	Natural.	A pearly thick mucus.
Spasmodic Asthma.	Sometimes impaired.	Usually weak, or even inaudible; but distinct, and even puerile, immediately after holding the breath a while.	Natural.	Little or none.
Peripneumony. 1st stage.	A little impaired.	Weak, with crepitant rhonchus.	Natural.	Viscid, of a rusty hue.
2d stage.	Quite dull.	Bronchial, with crepitant rhonchus.	Bronchophony.	Rusty, & very viscid, or none
3d stage.	Quite dull.	None; except sometimes a coarse mucous rhonchus.	None.	Sometimes purulent, sometimes brown and watery, often none.
Emphysema.	Unnaturally clear.	Diminished, and sometimes almost extinct. Cough accompanied by a sibilant rhonchus.	Natural.	Sometimes mucous; of a dirty grey colour.
Œdema.	Dull, if the effusion be extensive.	Weak, with subcrepitant rhonchus.	Sometimes slight bronchophony.	Slightly viscid and colourless pituita.
Pulmonary Apoplexy.	Dull, if near the surface, and extensive.	Extinct in the hæmoptoic spots; a rhonchus, first subcrepitant, afterwards mucous, around them.	Occasionally broncho-phony.	Blood, or bloody mucus.
Pleurisy.	Quite dull.	First weak; afterwards extinct, except at the root of the lungs.	At first ægophony; afterwards none.	None; or catarrhal.